Livelihood processes of gender roles and relations in water governance – A comparative study in Ethiopia and Argentina

Thesis submitted for the Degree of Doctor of Philosophy

School of Agriculture, Policy and Development

University of Reading

Laura Imburgia

November 2019

Declaration of Original Authorship

I confirm that this work is of my own authorship. All material used from other sources has been appropriately and fully acknowledged.

Laura Imburgia

Abstract

It is generally agreed that irrigation agriculture has become indispensable for securing the food supply of humankind, and as a way out of poverty for millions of small farmers. Gender asymmetries and inequalities in access to irrigation schemes and participation in their management remain serious. Particularly problematic is the low participation of women in the leadership of the self-governance of irrigation systems. This study sought to explore the livelihood processes of gender roles and relations in irrigation water governance within communal, self-governed small-scale irrigated schemes. The underlying hypothesis of this study is that gender differences and inequalities in irrigation agriculture management transcend even massive cultural differences. The study developed a novel integrative conceptual framework, informed by feminist, ecological and sociological theories, to provide better conceptualisation but also operationalise the analysis of complex interactions between technical and social dimensions of water governance. Fieldwork was conducted in Argentina and Ethiopia, culturally widely divergent locations. In-depth interviews with key informants, focus group discussions and surveys were combined in a mixed-methods research approach.

Key findings are:

Irrespective of the cultural setting, many women in irrigation agriculture remain constrained by structural inequalities driven primarily by entrenched power dynamics, social relations and wealth handicaps. These issues compound intrinsic disadvantages traditionally attributed to women, for example in meeting the physical demands of irrigation agriculture. Hence, technical aspects of irrigation agriculture and social relations interact in complex ways conditioning a set of constraints that seriously limit the ability of women to equitably participate in self-governance of irrigation schemes.

It is essential to view these findings juxtaposed to decades of donor- and government-driven efforts to devise agricultural development policies aimed at reducing gender asymmetries and strengthening the role of women in agriculture. While there are undoubtedly positive effects of these policies (greater visibility of women, much stronger legal protection), women still do not exercise their corresponding role in water governance. Low participation in governance translates into inferior decision-making power. There is strong evidence that inequitable participation in governance of water management has negative effects on its sustainability. In other words, there is a strong case for strengthening the inclusion of women and their decision-making power in irrigation self-governance. However, corresponding policies must explicitly recognise and respond to the complex interactions between the technical and social dimensions of irrigation agriculture, and how gender shapes these irrigation dimensions.

Resumen

Es ampliamente reconocido que la agricultura de riego se ha tornado indispensable para la seguridad alimentaria de la humanidad y como una forma de salir de la pobreza para millones de pequeños agricultores. Diferencias e inequidades de género en el acceso al agua de riego y en la participación de su gestión continúan siendo graves. Particularmente problemática es la baja participación de la mujer en el liderazgo de la gestión de los sistemas de riego. Este estudio buscó explorar los procesos de subsistencia vinculados a los roles y relaciones de género en la gobernanza del agua de riego dentro de esquemas de riego comunitarios y auto-gestionados de pequeña escala. La hipótesis subyacente de este estudio es que las diferencias y desigualdades de género en la gestión del riego trascienden incluso importantes diferencias culturales. El estudio desarrolló un nuevo marco conceptual integrador, basado en teorías feministas, ecológicas y sociológicas, para una mejor conceptualización pero también para hacer operativo el análisis de las complejas interacciones entre las dimensiones técnicas y sociales de la gobernanza del riego. El trabajo de campo se llevó a cabo en Argentina y Etiopía, lugares culturalmente divergentes. La investigación combinó entrevistas en profundidad, grupos focales y encuestas bajo el enfoque de métodos mixtos de investigación.

Los hallazgos claves son:

Independientemente del entorno cultural, las mujeres en el riego siguen estando limitadas por desigualdades estructurales impulsadas principalmente por dinámicas de poder arraigadas socialmente, relaciones sociales y desventajas económicas. Estos aspectos afectan desventajas tradicionalmente atribuidas como intrínsecas a las mujeres en el riego, por ejemplo, las demandas físicas de los sistemas tradicionales de riego. Por lo tanto, los aspectos técnicos de la agricultura de riego y las relaciones sociales vinculadas, interactúan de manera compleja y condicionan seriamente la capacidad de las mujeres para participar equitativamente en la auto-gestión de los sistemas comunales de riego.

Es esencial analizar estos hallazgos yuxtapuestos a décadas de esfuerzos impulsados por donantes y gobiernos para diseñar políticas de desarrollo agrícola dirigidas a reducir las brechas de género y fortalecer el papel de la mujer en la agricultura. Si bien existen indudables efectos positivos de estas políticas (como mayor visibilidad de las mujeres y mayor protección legal), muchas mujeres aún no ejercen un rol equitativo en la gobernanza del agua. La baja participación de la mujer en la gestión se traduce en un menor poder de decisión. Hay evidencias sólidas de que la participación desigual en la gobernanza del agua tiene efectos negativos en su sostenibilidad. En otras palabras, existen argumentos sólidos para fortalecer la inclusión de las mujeres y su poder de decisión en la auto-gestión del riego. Sin embargo, las políticas correspondientes deben reconocer y explícitamente abordar las complejas interacciones entre las dimensiones técnicas y sociales de la agricultura bajo riego, y las formas en que los aspectos de género influyen en esas dimensiones del riego.

Acknowledgements

I am truly thankful to my supervisors, Dr Sarah Cardey and Dr Henny Osbahr for their kind support, guidance and motivation along the PhD work. Special thanks for your intense help and encouragement during the final stages of this thesis.

My appreciation to the Huntley and Palmers Agricultural Research Studentship (University of Reading) for their financial contribution, and to the *Departamento General de Irrigación* of Mendoza for facilitating the logistics for the fieldwork. My gratitude to the IDRG faculty and PhD colleagues, and various staff members of the University of Reading for their support and assistance, especially while working away from the university.

I am obliged to the study participants of Tigray and Mendoza, especially the women and men farmers for their time and generous collaboration. I extend my appreciation to the many people in the agricultural and water sectors of Tigray and Mendoza that facilitated and supported this research. My especial gratitude to Laura Alturria, Lucía Pannochia, María Emilia Scatolón and Juan Pablo Yapura for their support during the fieldwork in Mendoza. Also, I am grateful to Gebrerufael Hailu for his support and facilitation of the fieldwork in Tigray. My appreciation to Asmeret Kidane, my translator and research assistant in Tigray, and Francisco Luca, my research assistant in Mendoza.

My deep appreciation to Janet Momsen for her generous help and mentorship. Your academic and personal integrity will always be an inspiration.

I also acknowledge and appreciate the insightful comments and editorial assistance of Epifania Amoo-Adare, Eduardo Herrera, Abena Serwaa and Adriana Uano.

Thank you to the dear friends who have accompanied this journey. Your support, motivation and cheerful love made a difference. Thank you, Adri, Dito, Mariana, Paula, Teresa, Nira and Raúl.

Thank you to my family, coping with the distance, supporting and loving me unconditionally, and making the family grow during my PhD journey. Thanks to my mother. I dedicate this thesis to you. And to the memory of my father.

I would like to give my special thanks to my husband, whose honesty, discipline and commitment are always important guidance. Your constant help, patient love and encouragement were essential to pursue and complete this work.

Para vos mami. Gracias por las alas.

Table of Contents

List of Acronyms and Abbreviations

DGI	Departamento General de Irrigación [Provincial Water Agency of Mendoza]
FGD	Focus group discussion
GDI	Gender Development Index
GDP	Gross Domestic Product
GII	Gender Inequality Index
GNI	Gross National Income
GIZ	*Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH*
Ha	Hectare
HDI	Human Development Index
HH	Household
masl	Metres above sea level
MDG	Millennium Development Goals
MoANR	Ethiopian Ministry of Agriculture and Natural Resources (federal level)
NRM	Natural resource management
O&M	Operation and maintenance
SDG	Sustainable Development Goals
SLMP	Sustainable Land Management Programme
SSA	Sub-Saharan Africa
SSIS	Small-scale irrigation systems
UNDP	United Nation Development Programme
USD	United States dollars
WC	Water committee
WUA	Water users' associations

List of Local Terms and Translations

tomero	Spanish word for water guard
inspector	Spanish word for WUA leader
inspección de cauce	Spanish form for WUA
criollo/criolla	Spanish word (masculine/feminine) for a person born in Argentina and European descendant
norteño/norteña	Spanish word (masculine/feminine) for a person born in northern Argentina and migrant in Mendoza
abomay	Amharic word for WUA leader
kebele	Amharic word for sub-district
woreda	Amharic word for district

List of Tables

List of Figures

1. Introduction

This thesis discusses livelihood processes of gender roles and relations in water governance in irrigated areas from widely differing cultural and economic settings. The study contributes to the understanding of three important issues in current water governance approaches and debates towards the goals of equality and sustainability: (1) how outcomes of self-governance of irrigation systems are gendered; (2) how and why current analytical gender approaches have limitations for the capture of the complex interactions inherent to the operation and governance of natural resources, including irrigation systems, and (3) what opportunities exist to achieve gender equality in collective irrigation. To this end, this research project used a comparative study approach of communal small-scale irrigation systems in Ethiopia and Argentina.

1.1. Background and rationale

Water is an overarching priority for communities in diverse rural livelihood systems of the world. Water availability and access limit the success of agriculture in many countries and regions. The increase in demand of water for growing populations is but one of the factors determining water constraints. Insufficient infrastructure to access the resource, power relationships determining inequitable share of the resource and social relationships that disadvantage certain groups in the sharing and management of water are also part of the recurrent water crises observed in many developing countries. Increasingly, groundwater over-draft, water pollution and deficient water quality are serious problems in many regions of the world. In addition, water is perceived to be becoming less abundant, rainfall more unpredictable and therefore access to water more unreliable.

Under the current socio-economic and environmental crises in diverse small-scale farming systems of the world, irrigation development remains a critically important strategy to increase agricultural productivity, secure agricultural livelihoods, enhance food security and, overall, overcome rural poverty for a large number of smallholders worldwide (Van Den Berg and Ruben, 2006; Namara et al., 2010; Gebrehiwot et al., 2015). The question of equality –regarding access to resources, participation in managerial decisions and benefit distribution- in connection with sustainability and long endurance of communal irrigation systems is an ongoing subject of study and debate (Baland and Platteau, 1999; Ostrom, 2011; Lecoutere, 2011; Senanayake et al., 2015; Oates et al., 2017). This is particularly relevant today as traditional, hierarchical, top-down water management institutions undergo transition processes towards more inclusive forms of participation (van Buuren et al., 2019).

Access to water is essential for all human beings, but a large portion of rural women seems to be affected disproportionately when this resource becomes limited (Hanson and Buechler, 2015), which is exacerbated in situations of conflict (for example Najjar, 2015). It is widely recognised that rural women are important water users (Zwarteveen and Meinzen-Dick, 2001; Bennett et al., 2008); in particular those belonging to households whose livelihoods are derived from small-scale agriculture with family labour (Chancellor, 2005; Zwarteveen and Bennett, 2005). The relationship between women and water has been recognised as being primarily linked to the domestic use of water, hygiene and sanitation (Bennett et al., 2005; Wallace and Coles, 2005). Only recently has it been recognized that women play a central role in irrigation agriculture - as beneficiaries, users, and actors in water organisations (Athukorala, 1996; Adams et al., 1997; Meinzen-Dick and Zwarteveen, 1998). Perhaps this may be explained by the observation that women are usually not considered farmers but rather ‘assistants’ of husbands or other family members in the farming activities; however women are often the ones responsible (Momsen, 2010) and they are usually not considered irrigators on their own right.

On the other hand, and due to diverse reasons, women today play a much more visible and active role in agriculture, including in irrigation, in many developing countries. Outmigration of male labour in Latin America, Africa and South Asia, and war, civil conflicts and the HIV pandemic in Africa are important contributing factors. Also important is the increasing number of low-wage jobs in high-value, export-oriented agro-industries of non-traditional crops (e.g. vegetables, flowers, fruits) or specialty markets of commodities (e.g. specialty coffee), for which preferably women are hired (Lyon et al., 2010; Momsen, 2010; Radel et al., 2012). Although difficulties in availability of consistent worldwide statistics of employment in agriculture, reference global figures indicate that in 2017 66.5 million women were employed in agriculture (FAOSTAT, 2019). This value represents 36% of all women and men employed in agriculture worldwide. Considering that a significant part of women’s involvement in rural work is non paid work, the proportion of women working in agriculture is considered to be underestimated (Momsen, 2010). Thus, it might be considered that this higher representation and participation of women in agriculture is not necessarily the result of societal development towards more gender equity, but rather borne out of economic necessity, much like the feminisation of industrial labour in World War I and World War II in the industrialised world.

It is well documented that within small-scale irrigation systems (SSIS), women are significant users of irrigation water (Wallace and Coles, 2005; Bennett et al., 2008). And yet, globally, gender differences remain evident in participation in irrigation scheme management and representation of water users in local irrigation governance structures, where male leadership dominates (Zwarteveen et al., 2010; Yami, 2013). A multitude of issues related to gendered social relations of power converge here, including control of and access to water (and other resources), traditional roles in the division of labour, unequal education opportunities, differentiated benefit-sharing mechanisms and incentive structures, and uneven gender participation and representation (Zwarteveen, 2008; D'Exelle et al., 2012; Agarwal, 2018). In many places, women continue to be deprived of secure tenure rights to land, while access to agricultural water rights from common water sources is usually dependent upon such land entitlements (Meinzen-Dick, 2014). This is a persistent source of gender difference and inequality that hinders poverty alleviation efforts (Agarwal and Herring, 2013; Meinzen-Dick et al., 2017).

Accessing and using communal irrigation water requires social organisation, which can manifest in multiple types of formal and informal water governance systems. Water users' associations (WUA) have been adopted (and remain) as the core element of self-governance of communal irrigation water resources in most countries. The promotion of WUAs took off in the 1980s with decentralisation of irrigation management and was largely driven by development donors, which sought to devolve management of irrigation systems from government level to farmers (Uphoff, 1986; Ostrom, 1993; Meinzen-Dick, 2007; Garces-Restrepo et al., 2007). Establishing WUAs became mandatory in the course of donor-financed irrigation development. There is a well-established literature on collective water management and the concept of participation is a cornerstone idea to understanding their effectiveness, sense of ownership of infrastructure, and financial and environmental sustainability (Tang and Ostrom, 1993; Ostrom, 2011; Senanayake et al., 2015). However, inclusive participation understood as a 'voluntary process' (Saxena, 1998) of equitable inclusion of voice and influence of all rural groups including many women and other traditionally disadvantaged groups (Saxena, 1998; Cornwall, 2003) continues to produce mixed results. This is so in diverse contexts in developing countries, and both in the domestic (Harris et al., 2015; Sultana, 2015; Adams et al., 2018) and irrigation water sectors (D'Exelle et al., 2012; Yami, 2013; Aarnoudse et al., 2018). Obstacles for genuine participation in WUAs are frequent, and mostly related to replication of unequal power relations existing in the community of users; diverging interest of users not appropriately addressed by WUAs; unequal share of decision making power with vulnerable water users -which include many women-, and incomplete decentralisation processes that determine discrepancies between the theory and operation of the WUA model (Senanayake et al., 2015; Aarnoudse et al., 2018).

1.2. Knowledge and methodological gaps

It seems to be clear that more opportunities exist today for gender-oriented development policies in agriculture than only 20 years ago. Accordingly, an active and growing field of research continues to develop in this area. Within the scholarship on irrigation and gender, the emphasis has been placed on access to water. However, gender issues have also reported other perspectives, including irrigation water governance and participation of women; gender roles and identities in farming, and social relations of gender in water access and use (Meinzen-Dick and Zwarteveen, 1998; Zwarteveen and Meinzen-Dick, 2001; Cleaver and Hamada, 2010; Nation, 2010). All these perspectives have supported the development of gender policies specific to agricultural development. However, while representation of women in the governance of irrigation agriculture systems, such as water users' associations (WUA) has been made mandatory (for example in India, Sri Lanka, Nepal), this is often of a symbolic inclusion of women and frequently too formalised to function effectively in practice (Van Koppen and Hussain, 2007; Zwarteveen et al., 2010). Even more problematic is the limited consideration of the issues specific to the women's role in irrigation agriculture when it comes to the design of technical interventions (for an exception, see Theis et al., 2018). This leads to the argument that those conversant with gender issues in agriculture at policy level are not always conversant with the technical specialities (and vice versa). A constructive, truly interactive dialogue between scholars, technical advisers in development and extension in irrigation agriculture and gender experts remains missing in practice. This can lead to ineffective programmes or missed opportunities in the technical development of irrigation systems, especially in the design and provision of extension services, and in ensuring governance conducive to resource conservation and equitable use.

Central to the understanding of self-governance processes and equality, and the particular impact on gender equality, is the role of WUAs in influencing livelihood processes and the share of irrigation scheme benefits among water users. Although the positive role of WUAs in improving access to agricultural water has been confirmed in case studies, the specific role that WUAs play in providing benefits to the associated livelihood processes (and the gendered implications) needs more investigation. In this regard, most studies have focused on the impact of irrigation management transfer on farm productivity and yields (for example, Gragasin et al., 2005; Bandyopadhyay et al., 2007). This perspective, however, is rather narrowly focused to explain wider benefits. Those seeking to develop a more holistic research perspective have mostly studied cases where WUAs were a result of donor-funded projects and had limited influence in water allocation and management (Franks et al., 2013; Yami, 2016). While these examples create a focus on the effects of institutional arrangements of irrigation water on livelihoods, they present context-specific cases where WUAs have a limited role on water access and management because of weak or non-functional collective systems. It seems to remain unclear what the defining characteristics of functional WUAs that shape the livelihood processes and the equitable involvement of their members are, when the aim is to promote sustainable rural development. Against this background, it becomes clear that the role that WUAs play in the viability of small-scale irrigation schemes, and consequently in rural development, needs more, and particularly more integrative and well-informed research.

While conducting gender assessments is now a required standard practice in most internationally funded natural resource management (NRM) and agricultural development programmes, advances in gender equality in the irrigation sector are not always commensurate with the gaps identified. This seems to be at odds with the urgency of the problem (Lefore et al., 2017). A thorough understanding of the dynamics of gender involvement in self-governed communal SSIS is fundamentally important to devise sound technical and policy interventions for equitable economic livelihood development and food security (Domènech, 2015; Theis et al., 2018). It is also a necessity in the analysis of complex interactions within and between the social and technical dimensions of irrigation agriculture.

In the study of water governance and equity in irrigation systems, there are scholars who have robustly integrated diverse theoretical perspectives, including an analysis of power (Brisbois and de Loë, 2016) and intersectionality, as relates to water, gender and other social differences (for examples, Harris, 2015a; Thompson, 2016). It is argued however, that these theoretical approaches are difficult to be used as operational tools (Hanson and Buechler, 2015). On the other hand, researchers and development organisations have developed a range of operational methods to collect and analyse gender-sensitive and gender-responsive data through scoring gender performance in small-scale irrigation schemes and projects based on pre-established sets of premises (Van Koppen, 2002; Alkire et al., 2013; Lefore et al., 2017). While these tools contribute in useful ways to systematic collection of data and to structure analyses, their quantifications are insufficient to understand and characterise socio-cultural and subtle power relations, as well as underlying drivers of gender difference (Akter et al., 2017). In addition, their effective implementation can be onerous and time consuming; especially when considering that development projects often only have very short time-frames available to conduct comprehensive gender and livelihood analyses.

From these premises, it becomes clear that there is the need for a comprehensive and theoretically robust framework that allows the capture of holistic views of the complex interactions inherent to the operation and governance of natural resources, including irrigation systems. This research project addresses this issue through the provision of an integrative conceptual framework that does not pose high operational challenges, but at the same time, it allows the analysis of complex, multi-dimensional interactions in the natural resource management. More specifically, as a gender-analytical framework, it seeks to examine the outcomes of the interactions of gender, social relations and irrigation practice within the context of collective water governance. The range of processes that govern these interactions are relevant to provide a comprehensive and nuanced understanding of how NRM, including water management, is gendered.

Scholarship on women and irrigation water has mostly analysed the reasons why women are not equally represented in organisations of collective water management, i.e., WUAs. However, the specific effects of changing patterns of participation and decision-making of women in local water resource management, in particular, what aspects improve when women take part in leadership, have not received equal attention. This is because of the difficulties to find sufficient evidence of tangible cases to assess those changes. The examples of women leading WUAs are simply too few. The study considered whether improving the participation of women as independent members of WUAs, and in particular allowing more women to occupy leadership positions, would strengthen the self-governance of irrigation water and provide a positive effect on the sustainability of the SSIS. This is important because the literature suggests that poorly socially 'rooted' WUAs jeopardise effectiveness and equality of water management and, as a result, the sustainability of the organisation. Therefore, the study sought to explore the mechanisms of female and male participation in WUAs, the reasons for the low participation of women and the opportunities and enabling conditions for increasing the involvement of women in water governance structures.

1.3. Reasons for a comparative study and for the selection of Ethiopia and Argentina

This study sought to understand patterns of gender roles and relations in access, participation and decision making in irrigation water governance. A comparative, trans-regional study allowed comparison of manifestations, similarities and differences in those processes in diverse socio-economic and cultural settings (Bryman, 2012). In addition, a high diversity of data was required to test the integrative gender-analytical framework developed for this investigation. This diversity was pursued through two main approaches: first, designing a multi-case study in two countries, and second, by using a mixed-method research approach as it will be further explained in Chapter 3 (Methodology). Tigray in Ethiopia, and Mendoza in Argentina, offered a representation of diverse irrigation and cropping system; various types of WUAs and socio-cultural background. Those characteristics will be described in Chapter 4 (Context).

1.4. Reasons for focusing on communal small-scale irrigation systems

Under the current conditions of socio-economic and environmental vulnerability of many rural areas, and complex challenges for subsistence, irrigation agriculture is seen as a key strategy to overcome poverty and to cope with increasingly unreliable rainfall. In developing countries, small-scale irrigation systems represent the majority of agricultural water users. This is also the case in the study locations of this research. For example, in Tigray, an agriculture-dependent economy, the large majority of the 86.4% of farmers practicing agriculture, are smallholders (WWDSE&CECE, 2014a). In Mendoza, about 48% of irrigated farms are of size considered smallholders in that context (Imburgia, 2017). It is also well-documented that within the small-scale irrigation systems, women are significant users of irrigation water (Wallace and Coles, 2005; Bennett et al., 2008). Therefore, the study of communal small-scale irrigation schemes presents an opportunity for examining the diverse and complex interactions between the technical and social dimensions of natural resource management, including those of gender. It also offers the possibility to examine those issues at different scales: the individual farm setting, the water users' organisations and the interactions with the higher, governmental levels.

1.5. Aim of the research, objectives and research questions

The overall goal of the study was to understand the limitations of development strategies and programmes to achieve gender equality in irrigation water resource management. These limitations stem from a number of interrelated conceptual and methodological factors in analysis that interact with the agro-ecological and 'technical' dimensions of the irrigation practice. In addition, in many rural and agricultural contexts today, common gender roles are changing. In some places, those changes occur rapidly. In the particular sector of self-governed irrigation systems, social, environmental, and financial sustainability of small-scale farming is a matter of concern. By developing and using an integrative conceptual framework, this study can broaden the understanding of *who* accesses and uses the resources, and *how*; and *who* benefits and *who* loses in the communal management of irrigation water resources. This will be done by examining configurations of social relations of power as a core element of the conceptual framework filtering and/or catalysing the agroecological and environmental processes.

Specifically, the research aim is to understand and describe livelihood processes of gender roles and relations in water governance in irrigated areas of northern Ethiopia and central Argentina. The corresponding research objectives and questions are outlined below.

Research Objective 1:

To explore the patterns and dynamics of gender roles in small-scale irrigation water governance in relation to gender relations across different cultures and socio-economic settings.

a. What are the strategies or mechanisms (formal and informal) different groups of women and men develop to gain access to and control of irrigation water?
b. How are the processes of decision making across different cultures and socio-economic conditions in irrigation practice determined in regards to (a) gender roles, (b) power relations and (c) barriers to gender equality?
c. Does an increased share in decision-making power in WUAs lead to secured water access for different groups of women? If so, how? Why?

Research Objective 2:

To examine patterns and dynamics of participation and decision making of different groups of women and men in local water resource management, and effects on inequalities and on livelihood processes.

a. How changes in governance (decentralisation) impact on water resource management? If there is benefit, who benefits?

b. Do changing patterns in decision making in WUAs lead to reallocation of resources in favour of more equitable water resource management? If so, how? Why?
c. What are the factors and mechanisms that shape participation of different groups of women and men in water governance organisations?

Research Objective 3:

To identify and evaluate the conditions, opportunities, and constraints for increased participation and decision making of women at water resource management sector level.

a. What are the constraints, opportunities and enabling conditions for formal and 'transformative' involvement of women in water governance structures and sector policies?
b. What are the implications for an increased participation of women in leadership?

1.6. Considerations regarding the researcher's position and the selection of the research approach

The research questions and the decision to conduct a cross-regional comparative study are the result of almost two decades of work as a development practitioner and agricultural and gender advisor in a number of very diverse countries. My main focus was on supporting poverty in rural areas, which have included many irrigated contexts. The need to find solutions leading to more equitable access to water, and control and decision making for women is shared by all regions and countries I worked in. The gap between women and men in access to resources and their ability to make a satisfactory and durable living from their agricultural livelihoods have been recurrent problems. During my work, I also have had the opportunity to closely work with rural women struggling to make their way to decision-making positions because they understood that many gender gaps and inequalities needed to be brought up to the managerial levels.

By contrast, all projects have had high delivery promises on gender equality with often clear mismatch with results. Moreover, situations in which external programmes have aggravated gender asymmetries and distorted (more sustainable) endogenous ways of managing resources have been regrettably commonly found. In those situations, I often realised the problem of insufficient problem analysis, for instance, because of not understanding gender differences in access to resources; overlooking differences and hierarchies within different groups of users, whether women or men, and importantly, considering gender issues as separate from the 'technical' themes of NRM projects.

In most international funded projects in which I have worked, conducting gender assessments has been a required practice. However, when working in the field, I realised that I needed a robust conceptual framework for identifying key problems and their interactions, which could address the most critical points from the outset. Besides robust and comprehensive, this tool should also be suitable for the rapid assessments typically required by the short development project cycles. In reviewing the literature on women, gender and irrigation I realised that none of the existing relevant gender-analytical frameworks was entirely meeting these requirements. I concluded that a comprehensive analysis examining all interrelated factors, with a methodology going beyond the single case study approach while not posing high operational challenges was needed. As a result of these experiences, I became motivated to study the nuanced reasons why institutions, programmes and organisations fail to achieve gender equality in irrigation water management; what contributions can be made to the usual ways of conducting gender analyses, and how this understanding could contribute to more effective policy and practice.

1.7. Thesis structure

The thesis was developed as a collection of academic articles and structured in order to cover the following thesis sections:

Chapter 1 - Introduction. This chapter presents the background of the study with an overview of the importance of irrigation water and small-scale agriculture in development. It outlines the key research topics of the study: gender roles and relations in irrigation; access, participation and decision making in water governance, and effect of self-governance institutions in livelihood processes and equality. The section also describes the rationale of the study, the research aim, objectives and questions, and the structure of the thesis.

Chapter 2 - Literature review. This chapter reviews the definitions and conceptualisations of water governance that are central to this thesis, with emphasis on water access and rights; participation in water governance, and social relations of gender. The chapter provides reviews of the conceptual intersections between those themes in order to develop a theoretical background for the study; it examines scholarship related to gender roles and relations in small-scale irrigation systems, dynamics of participation and decision making in water users' associations, and conditions and opportunities for increased participation of women in irrigation management. Finally, the conceptual framework developed for this research study is explained.

Chapter 3 – Methodology. This thesis section presents the research approach and design, including a discussion on the choice of a comparative, trans-regional, multi-case research approach and the use of mixed-research methods for data collection. The chapter also provides a brief overview of the research areas, and discusses sampling approach, methods of data analysis and interpretation, and considerations regarding the fieldwork challenges, researcher's position and ethics in the research.

Chapter 4 – Context. This chapter introduces the targeted study research areas: Tigray in northern Ethiopia, and Mendoza, in centre-west Argentina. The chapter provides background on socio-economics, livelihoods and local water resource characterisations that are useful when contextualising the analysis chapters on small-scale irrigation systems and irrigation water governance.

Chapter 5 - The article **'Irrigation and equality: An integrative gender-analytical approach to water governance with examples from Ethiopia and Argentina'** discusses the importance of developing an integrative gender-analytical approach that enables both researchers and practitioners to analyse the complex interactions between technical and social dimensions of water governance, in order to determine how they contribute to, and thus effect, the overall success and sustainability of irrigated agriculture. The paper provides a detailed account of the framework's key components. There is also an account of the framework's application using data from the study of small-scale irrigation systems in Ethiopia and Argentina. The question: *What are the outcomes of the interactions of dynamics of gender, social relations and irrigation practice within the context of collective water governance?* was examined. This article has been published in Water Alternatives Journal, 12(2): 571-587. Author: Imburgia (2019).

Chapter 6 - The article **'Application of an integrative gender analysis of small-scale irrigated agriculture and women's agricultural livelihoods'** seeks to make operational the conceptual framework developed in Chapter 2 and 5 by using it as a methodological approach to comparatively explore the way that agro-ecological, technical, infrastructural, financial and socio-cultural processes take place in small-scale irrigation schemes. The framework is applied at the farm unit level. This helps to better understand why and how gender is an important factor shaping access to secure, reliable, and affordable irrigation water for many female farmers, and how this gender factor is influenced by processes of social differentiation present across different cultural and socio-economic settings. This article seeks to address the questions *what are factors and mechanisms (formal and informal) different groups of women and men develop to gain access to and control of irrigation water in small-scale irrigation systems (SSIS)? Are there common patterns of social differentiation in small-scale irrigation that arise despite differences in cultural and socio-economic settings?* This article has been submitted for review to the Journal of Development Studies. Authors: Imburgia, L., Osbahr, H., Cardey, S. and Momsen, J.

Chapter 7 - The article **'Rural development and the role of water users' associations in overcoming inequalities and sustaining small-scale irrigation agriculture'** explores participatory outcomes of WUA governance, in particular regarding challenges to equality in view of rapidly increasing water supply problems and the severe profit crisis of small-scale agriculture. Opportunities to overcome barriers to equality are discussed. *Under the extreme complex contexts of water availability, how and why do local institutions of water management affect equality in access to irrigation water, participation and decision making of communally managed irrigation systems?* In highly regulated water governance systems, as in Argentina and Ethiopia, *what role do WUAs play in overcoming barriers to equality*? This article suggests answers to these questions by utilizing data from the multi-centred field studies in Ethiopia and Argentina and by applying the integrative analytical approach at the WUAs' scale. This article has been submitted for review to the Journal Development and Change. Authors: Imburgia, L., Osbahr, H. and Cardey, S.

Chapter 8 - The article **'Inclusive participation, self-governance and sustainability: Current challenges and opportunities for women in leadership of communal irrigation systems'** presents evidence suggesting that improving the participation of more women as independent members of WUAs, and in particular allowing more women to occupy leadership positions, have the potential to strengthen the self-governance of irrigation water with positive effect in the sustainability of the SSIS. It further argues that incomplete participation of water users in water management that includes a very low representation of women in management and leadership, determines that WUAs are not well rooted in their community of users. Based on these interlinked assumptions, the article specifically seeks to answer: *What are the mechanisms of participation of women and men in WUAs? What are the reasons for low participation of women? What are the opportunities and enabling conditions for increasing the involvement of women in water governance structures?* This article has been submitted for review to the Journal Environment and Planning E: Nature and Space. Authors: Imburgia, L., Cardey, S., Osbahr, H. and Momsen, J.

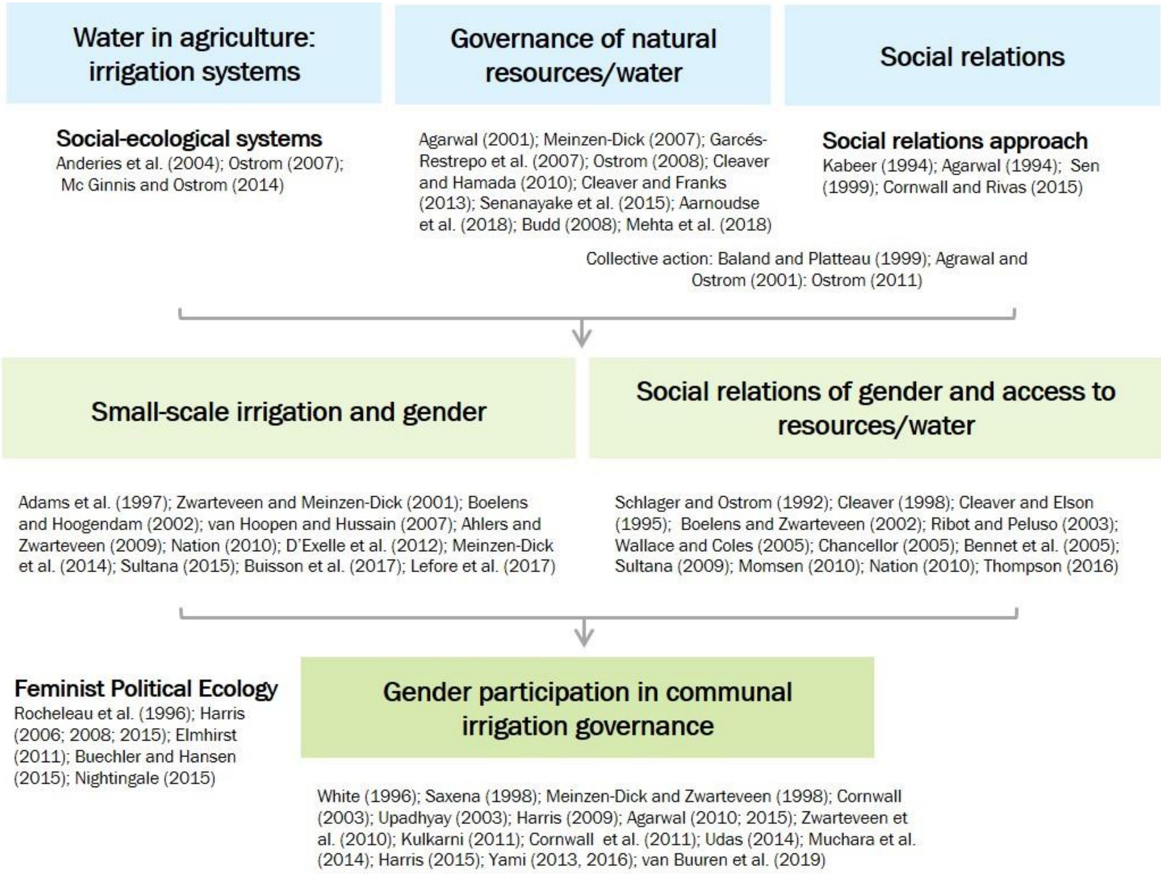
Chapter 9 – Conclusions. This concluding chapter integrates the main findings and overarching conclusions that emerged from the four research articles by linking them to the research objectives. The chapter presents the research main findings and conceptual significance, outlines the thesis contributions to knowledge, discusses policy and practice implications from the findings, and provides considerations for future research.

2. Literature Review

This chapter reviews the key ideas that underpin this research within the broad debates about water in agriculture, governance of water resources, and social relations of gender (Figure 2.1). It then discusses the specific themes that connect these debates and which reflect the focus of this research: small-scale irrigation water governance, the social relations of gender and access to water resources, and gender participation in irrigation governance. These specific themes are further elaborated upon within Chapters 5 to 8, which comprises four academic papers, relating these specific themes to the study locations within Ethiopia and Argentina (see section 1.7. Thesis structure).

This chapter will first provide an overview of the definitions and conceptualisations of water governance, with emphasis on water access and rights, collective water management, and social relations of gender (Section 2.1). Second, the intersections between these conceptual elements will be explained in relation to the focus from the research objectives to examine the debates related to gender roles and relations in small-scale irrigation systems (Research Objective 1) (Section 2.2 and 2.3), dynamics of participation and decision making in water users' associations (Research Objective 2) (Section 2.4), and conditions and opportunities for increased participation of women in irrigation management (Research Objective 3) (Section 2.4.4). Drawing upon feminist political ecology, a social-ecological systems approach and the social relations framework, a conceptual framework is then developed (Section 2.5) to organise the interconnection between these themes for this research study.

Figure 2.1 Theoretical approach for the research



Source: Developed by the author.

2.1. Definitions and conceptualisations

This section will review the key definitions within water governance (as detailed in Figure 2.1), and their theoretical conceptualisation. The focus of this research explores gender roles and relations and how these relate to issues of access to, and use of, water for agriculture, and therefore references to water resource management and governance used in the text will imply irrigation water. At the local level, these issues will be analysed from the perspective of local structures of self-governance of communal irrigation schemes, i.e., water user associations (WUAs).

2.1.1. Water governance

Governance of water resources has been highlighted as one of the key priorities for policy makers and donor agencies in the last two decades (OECD, 2018; GWP, 2019). This has conditioned funding priorities by international development agencies and governments

(Tortajada and Biswas, 2011; Lautze et al., 2014). Irrigation water has the particular characteristic that in order to be accessed and used, certain social organisation is necessary, which in turn determines types of water governance. According to Meinzen-Dick (2007), during the last decades, three types of governance regimes were promoted as ‘panaceas’ (Ostrom et al., 2007) to improve water management: strong state institutions, user organisations, and water markets. This sequence of institutional approaches, Meinzen-Dick argues, attempted to solve the problems unresolved by the previous approach; however, those approaches were based on simplistic perceptions of successes and failures that led to ‘unrealistic expectations’ (2007). A ‘polycentric combination’ of diverse institutional arrangements for water governance was therefore proposed to counteract the deficiencies in single governance systems (Meinzen-Dick, 2007).

The study will consider water governance as providing a policy and ruling framework (organisational function) for water management (operational function). Thus, in the context of communal irrigation systems, water governance will entail the process of policy making, the establishment of appropriate administration structures, and the process of allocating decision-making power related to management (operational) activities (Tang and Ostrom, 1993). The issue of how to equitably include farmers with decision-making power and capacity to define their own frame of rules and regulations, in both the governance and management of irrigation systems (Tang and Ostrom, 1993), is of central interest of this research study and it will be explored in the rest of this section.

2.1.2. Water access in irrigation systems

In rural areas of developing countries, water access for agriculture can be realised through formal or informal water rights. It is also possible to access water by sharing other’s rights, with or without the consent of the right’s holder, e.g., head of household, relative, or by a trade or barter agreement with a neighbour (Ribot and Peluso, 2003). All those ways to accessing water respond to a range of social relationships, and hold diverse degrees of security, equity and justice (Crow and Sultana, 2002). Property rights, which include water rights, are also conceptualised as a ‘bundle of rights’ involving diverse types of actors that may hold different types of rights (Schlager and Ostrom, 1992) (Table 2.1). This ‘bundle of property rights’ has critical implications in the management of natural resources in terms of determining ‘incentives’, ‘actions’ and ‘outcomes’ for right holders (Schlager and Ostrom, 1992).

Table 2.1 Bundle of rights associated with positions

Property rights	Owner	Proprietor	Claimant	Authorised user
Access and withdrawal	X	X	X	X
Management	X	X	X	
Exclusion	X	X		
Alienation	X			

Source: Schlager and Ostrom (1992).

Water rights in this study will be understood according to the definitions provided by Beccar et al. (2002), based on Schlager and Ostrom (1992):

- *Operational rights* refer to the rights to use parts of the resource and the hydraulic infrastructure, and to participate in the water user associations with decision-making power, thus occupying decision making positions -'access' and 'withdrawal rights' according to Schlager and Ostrom (1992).
- *Collective decision-making rights* refer to rights to take part in decisions concerning transferring of rights (who can be part of the resource system) and exclusion from them (who cannot); interventions in the hydraulic infrastructure, and/or organisation and management of the irrigation system (according to Schlager and Ostrom (1992): 'collective-choice level' rights include 'management', 'exclusion' and 'alienation' rights).

Water systems entail the simultaneous occurrence of different regulatory frameworks: constitutional, customary and even religious, such a combination being described as legal pluralism (Boelens and Zwarteveen, 2002; Boelens and Vos, 2014). According to Meinzen-Dick (2014), these multiple forms of regulation determine property rights and rules for the use of resources and they can frequently be complementary. However they can also overlap, be 'inconsistent' and cause conflict among users and the state, thus requiring adaptation of water rights (Beccar et al., 2002).

2.1.3. Collective water management and the role of water users' associations

The access to communal irrigation water and its use requires social organisation, which can manifest in multiple types of formal and informal water governance systems. Water users' associations (WUAs) are participatory entities legitimised as the local decision-making platforms for collective water resource management (Kemerink et al., 2013). The role of WUAs is to manage the process of water distribution planning and use, and to resolve conflict. WUAs are also useful to make formal water rights operational (Meinzen-Dick, 2014); to link higher level governance structures with local management entities, and often, to channel external resources to the community level (for examples, see Zwarteveen et al., 2010; Yami, 2013; Ortega-Reig et al., 2017). The establishment of WUAs has become an accepted approach to operationalise water management decentralisation. Indeed, WUAs remain the core element of self-governance of communal irrigation water resources in most countries. The promotion of WUAs that grew in interest in the 1980s, with decentralisation of irrigation management, was largely driven by development donors and sought to devolve management of irrigation systems from government level to farmers (Uphoff, 1986; Ostrom, 1993; Garces-Restrepo et al., 2007; Meinzen-Dick, 2007).

2.1.4. Social relations of gender

Within the theories of development, gender and development (GAD) emerged by the late 1980s to understand and question the mechanisms and structural causes of unequal power relations between men and women (Visvanathan et al., 2011). Those relationships had been accepted as 'natural' within the previous gender discourses (Peet and Hartwick, 2009).[1] Authors of GAD were also critical of the lack of attention of development policy and practice on gendered social relations within the broader political context, demanding from the state and official policies 'strategic interventions' for genuine social change (Peet and Hartwick, 2009; Rai, 2011). The development discourse of the last two to three decades assimilated the concept of 'gender' to explain only a part of social relations: the one that only recognises a disadvantage position of an undifferentiated collective of women in their relationships with an undifferentiated collective of *dominant* men (Cornwall and Rivas, 2015). Critiques emphasise that various forms of difference between actors and *intersectionality*[2] have not been included. This has overlooked different positive relationships that men and women may establish, e.g., collaboration, mutuality and equity, or unequal relationships, based on aspects other than gender but age,

[1] A number of comprehensive accounts of the evolution of the conceptualisations of women, gender and development are helpful to understand why and how the concepts of social relations and gender relations began to populate the feminist analysis of development (Peet and Hartwick, 2009; Momsen, 2010;Visvanathan et al., 2011) including natural resource management (for example, Rocheleau, 1996).

[2] Intersectionality refers to the diverse interactions between actors of multiple categories, i.e., gender, class, ethnicity, and the results of those relationships, usually reflected in hierarchical forms of discrimination (McCall, 2005). Cornwall and Rivas (2015) particularly stress the lack of consideration in the development discourse of aspects such as diversity of male and female identities; relations of power; asymmetrical relationships between same sex individuals, and people of diverse class, race or economic status.

ethnical origin, and economic, social or political influence (Cornwall and Rivas, 2015). Likewise, limited attention to social relations has been pervasive within the water and development sector (Cleaver and Elson, 1995; Cleaver, 1998; Chancellor, 2005).

In her influential book *A Field of One's Own,* Agarwal (1994) describes gender relations as

> the relations of power between women and men which are revealed in a range of practices, ideas, and representations, including the division of labour, roles, and resources between women and men, and the ascribing to them of different abilities, attitudes, desires, personality traits, behavioural patterns, and so on. Gender relations are both constituted by and help constitute these practices and ideologies in interaction with other structures of social hierarchy such as class, caste, and race. They may be seen as largely socially constructed (rather than biologically determined), and as variable over time and place. (Agarwal, 1994: 51).

Gender relations determine social hierarchies not only between men and women, but also between same sex individuals, within the sphere of the family and household and outside in the interactions with the society (Agarwal, 1994).

As a result of social interactions, diverse types of gender relations emerge due to the existence of 'congruent and conflicting interest' as described by Amartya Sen in his 'cooperative conflict' model of intra-household gender relations (Sen, 1999). Additionally, 'cross-cutting inequalities' including poverty, are usually a result of social interactions (March et al., 1999). Even though gender relations vary greatly in time, location and culture, unequal power relations between men and women are recognised to result in generalised asymmetries mostly to the detriment of certain groups of women (Momsen, 2010).

2.2. Gendered social relations, power and access to resources

This research will use a 'political' perspective to analyse gender relations because social relations of gender are subordinated to diverse arrangements of power. Likewise, access to and management of natural resources are influenced and defined by a social, economic and political balance of power (Rocheleau et al., 1996). Elements of two analytical frameworks are useful to conceptualise power (a) in access to and control of resources and (b) in social relations of gender. These elements will be included in the development of the conceptual framework for this study in Section 2.5 and are explained below.

(a) Gender relations and access to resources – Agarwal's conceptual framework. Access to and control of resources within and outside the household are shaped by the type and dynamics of social relations and the 'bargaining power' that an individual retains (Agarwal, 1994). Intra-household relationships can be 'cooperative' or 'conflictive', or simultaneously both (Agarwal, 1994: 52). The cooperative interactions are characterised by how beneficial those interactions are for each individual in comparison to non-cooperative interactions (Agarwal, 1994). The most relevant mechanisms shaping bargaining power within gender relations were analysed by Agarwal (1997) inside and outside the household or family, in the market, in the community and in the state. Those mechanisms include: the individual's 'fall-back position'[3]; social norms; effect of gender differences; 'qualitative aspects of power'; and influence of 'extra-household' bargaining capacity. Agarwal worked extensively on the analysis of land issues in South Asia, and concluded that limited access to property rights is a critical source of the gender unequal bargaining position within the family and society (Agarwal, 1997).

(b) Balance of power and decision making –Kabeer's conceptualisation of empowerment: Kabeer (1999) defines empowerment as a process through which the 'ability to make choices' (i.e., to have power) is gained or recuperated. So defined, any process of 'empowerment' implies the existence of 'a condition of disempowerment' at some point (Kabeer, 1999: 437). Kabeer (1999) describes having power or to become *empowered* in relation to three interconnected aspects: *resources*[4], *agency*[5] and *achievements*[6]. Both resources and agencies are constitutional elements of the capacity of an individual to determine the type of life, the choices, the preferences, and the priorities he or she desires (Kabeer, 1999) in order to develop an autonomous life. Therefore, 'empowerment' as an individual process determines how a person positions her or himself in relation to her or his identity (Kabeer, 2005). In turn,

[3] Agarwal (1994: 54) defines fall-back position as: 'the outside options which determine how well off he or she will be if [intra-household] cooperation ceased.'

[4] Resources: A person has the ability to access material and non-material *resources* and rights to claim those resources 'through a multiplicity of social relationships conducted in the various institutional domains which make up a society (such as family, market, community).' (Kabeer, 1999).

[5] Agency: A person has the ability to establish what he or she wants, to make decisions upon and to pursue those goals as an exercise of *agency* ('power within') (Kabeer, 1999). This decision making capacity can have a positive connotation ('power to'), if it refers to the individual ability to exercise *agency,* or a negative connotation ('power over'), if it refers to unequal individual or collective relationships in which the *agency* of others is not respected (ibid).

[6] Achievements of agency occur when a person realises outcomes from her or his full capacity of decision making (Kabeer, 2005).

empowerment as a collective process encompasses a social transformative capacity engendering ‘multidimensional processes of change’ (Kabeer, 2011).

The feminist political ecology (FPE) framework offers a useful analytical approach for examining the mechanisms that govern social relations and natural resource management and is one of the core elements of the conceptual framework developed for this research. The FPE framework incorporates all social relations as determinant variables, i.e., those that explain local and global ecological, economic and development processes. It assumes the existence of social differences and inequalities, in particular those related to gender (Rocheleau et al., 1996), and allows a more comprehensive understanding of the material results of those inequalities, such as property rights allocation, poverty, and location of decision-making power.

2.2.1. Social relations and property rights

Property rights are described as originating relationships between resource users positioned around a certain resource (Ahlers and Zwarteveen, 2009; Meinzen-Dick et al., 2014) and corresponding power allocations and authorities’ hierarchy (Boelens and Zwarteveen, 2002; Boelens and Vos, 2014). Analysing water rights from the social relations perspective is useful to understand not only their complexity, but also the differences regarding property rights of other resources such as land. Water property and water tenure cannot be understood in terms of owned units of the resource but as a complex network of elements, including cultural symbols, traditions, local uses and values, the necessary technology and infrastructure to make the resource accessible and useful, and the necessity of organisational forms based on collective management (Ahlers and Zwarteveen, 2009). Thus, water rights are understood as social agreements made under certain physical, cultural, economic, political, legal and agro-ecological circumstances. Any of these circumstances may change requiring adaptation of water rights (Beccar et al., 2002).

It has been a recurrent concern for feminist scholars as to whether formalisation of rules and procedures, such as property rights, are the best way to reduce gender inequalities (Ahlers and Zwarteveen, 2009). Agarwal (1994) structures the reasons for women’s need to hold independent land rights into four related categories of arguments: (1) *welfare*, referring to economic production to be protected against poverty; (2) *efficiency*, in terms of adoption of improved technology, and motivation to adopt better agricultural practices and maximise agricultural outputs; (3) *equality* and (4) *empowerment*. These categories can be discussed in terms of how, through unequal distribution of land rights, gender inequalities shape not only economic spheres but also social and political structures.

Gender, social relations and property rights have been extensively analysed for land tenure (Agarwal, 1994). Independent property rights for women help secure means of agricultural production, food security, control over the own income and strengthened bargaining power, while presumably also helping access to credit, extension services and information (Meinzen-Dick, et al., 2017). In a comparative study of land property rights and gender distribution of wealth, evidence from Ecuador, Ghana and India, Deere et al. (2013) found that legal frameworks that show higher levels of gender equality in terms of community property in marriage, inheritance rights among children and recognition of contributions of both partners to marital property, ensure higher degrees of gender equality in the broader aspects of wealth distribution and accumulation. Although land policy reforms in many developing countries have effectively strengthened land rights of individuals within households, a gender gap in land security for women is still of concern (Lastarria-Cornhiel et al., 2014).

2.2.2. Gendered mechanisms and factors to access water

A focal interest for this research is how to empirically explore the strategies or mechanisms (formal and informal) different groups of women and men develop in order to gain access to, and control over, irrigation water across different cultures and socio-economic settings. Furthermore, this research seeks to examine the factors that influence women's access to water and formalisation of these water rights. The scholarship on women, gender and water is mostly situated within a broad gender and development discourse, and the gender and environment field of studies (Ray, 2007). Within the scholarship on irrigation and women, emphasis has been placed on access to water. Right of access to irrigation water is usually associated with land ownership, where strong gender inequalities persist in many parts of the world (Agarwal and Herring, 2013; Meinzen-Dick et al., 2017).

A review of this literature indicates that access to water rights is gendered in diverse ways, and water rights tend to be concentrated on the benefits for men. Although many women access water through their 'collective family rights' (Boelens and Zwarteveen, 2002), those rights entail a diverse degree of security for women. Table 2.2 presents a description of gender gaps in accessing rights to water, based on a typology developed by Boelens and Doornbos (2001) and used by Boelens and Zwarteveen (2002), as well as additional worldwide references.

Table 2.2 Examples of gendered mechanisms to access water rights

Types of water rights	Gendered dimensions on accessing water rights
Concessions *Formal water rights are granted by the state on the basis of land ownership, and/or conceded to 'household heads'.*	• When only household heads have access to land rights, a limited number of women are able to acquire those entitlements, namely some of the divorced or widowed women in a community (Boelens and Zwarteveen, 2002). • In many parts of the developing world the majority of the ownership and control of productive assets lies with men (Agarwal, 1994; Momsen, 2010). This includes land property, inputs, technology, capital, and information. When access to water depends on any of those resources, in particular land ownership, women face more difficulties to access water than men (Crow and Sultana, 2002).
Historic and socio-territorial rights *This type of rights derive from a 'prior appropriation'; socio-territorial water rights derive from a 'socio-geographical territory', e.g. 'riparian rights' (Boelens and Vos, 2014).*	• Accessing these rights will strongly depend on the status as community members that the community attributes to men and women (Boelens and Zwarteveen, 2002). • There is evidence that cultural or customary patriarchal traditions challenge equal women recognition, public involvement or status as community members (Boelens and Zwarteveen, 2002). • In other occasions, historical water rights have determined unequal access for new irrigators; for example, in some peasant communities in inter-Andean valleys in Bolivia (Saldías et al., 2013).
Transfer of water rights between right holders *Water rights are acquired by various mechanisms of transfer, i.e. inheritance, endowment, sale, rental, barter, donation, or marriage.*	• Boelens and Zwarteveen (2002) indicate that gender bias to acquire water rights will depend on a number of contextual aspects, namely: local customary rules (especially evident for inheritance and marriage), gender differences in financial status and market access, and the social status of women and men in the local society.
Acquisition of water rights by force (legalised within the local rules and institutions)	• Cases of expropriation by powerful groups are included here (i.e. landlords, powerful enterprises such as mining or agribusiness) which result in problematic situations for all smallholders, regardless of gender (Boelens and Zwarteveen, 2002). For example, Mehta et al. (2012) and Cotula (2012) analyse the dramatic changes and potential conflicts that 'water grabbing' connotes for communities whose livelihoods depend on agriculture.
Users' investments *Water rights can be obtained by investing own labour, time or material resources in the irrigation system management.*	• Gender-based limitations to women may occur due to traditional cultural determinations, which consider that women are not suitable to work in the maintenance of the hydraulic infrastructure (Zwarteveen, 1997; Adams et al., 1997; Zwarteveen, 2011). • When participation of water governance organisations is a requirement for accessing and/or maintaining water rights, women may face limitations not experienced by men due to relatively lower female participation. Strong cultural patterns usually prevent women from participating in these public events (for examples from South Asia: Agarwal, 2010; Clement, 2012; for examples from Latin America: Bennett et al., 2005).

Source: based on a description and the water rights framework used by Boelens and Zwarteveen (2002).

2.2.3. Factors influencing irrigation water access from a social relations perspective

The key issue defining access to irrigation water is security in land access. Independent possession of land titles is still uncommon for women, compared to men, in many countries (Agarwal and Herring, 2013; Meinzen-Dick et al., 2017). A number of authors have explored the implications of the mechanisms of water rights acquisition for broad social and gender equity in irrigation (for example, Boelens and Zwarteveen, 2002), and for specific managerial issues such as irrigation technology adoption (Theis et al., 2018) as those rights are shaped by cultural symbols, traditions, local uses and values (Ahlers and Zwarteveen, 2009) and mostly vested in men (Zwarteveen and Bennett, 2005). Issues of water tied to land are also relevant in terms of the impact of land use practices on water availability and quality, and vice versa. Issues of land grabbing (Cotula, 2012), lack of property rights for vulnerable groups (Narain, 2014) and legal pluralism may shape the gendered transfer of land rights and consequently this affects access to water rights.

The level of economic power and wealth an individual has provides the fundamental mechanisms that help to secure water rights, as observed in traditional irrigations systems in Bolivia (Mehta et al., 2012), in Tanzania (Franks et al., 2013) and in Bangladesh (Crow and Sultana, 2002). Better-off women are able to overcome gender limitations in acquiring water rights by contributing paid labour in Kenya (Adams et al., 1997) and Latin America (Bennett et al., 2005).

Although unequal social (gendered) and economic power relations are critical and overlapping factors influencing security of access to water, these factors tend to be iteratively affected by material inequalities that constrain secured access to the resource. Ownership of water rights must be maintained by investing time (attending water management meetings); effort (physical work on maintenance) or capital (paying water fees, hiring labour, or purchasing materials) (Bossenbroek and Zwarteveen, 2014). At the household level, the way incomes are controlled and distributed between the household members, thus determining their individual bargaining power (Agarwal, 1994), may be more influential in decision making over water use than holding individual water rights (Bastidas, 2005; Bossenbroek and Zwarteveen, 2014).

When the irrigation management system in place lacks formal water rights, or when water users need to complement insufficient water allocated by formal water rights, informal mechanisms to access and secure water are found and used as adaptive strategies to allow water access to certain groups that would otherwise be excluded from access (e.g. some women, poor people, the landless) (Zwarteveen, 1997; Jackson, 1998). As those informal mechanisms may be sustained by social relationships (Zwarteveen, 1997; Bennett et al., 2005; Bossenbroek and Zwarteveen, 2014), the degree of equity of such mechanisms will vary according to traditions and customary rules (Adams et al., 1997).

The fact that many women in need of agricultural water are not prevented from accessing the resource mediated by their husbands or relatives, or through informal mechanisms, raises the question: why is it then necessary to formalise individual water rights for those women? Anecdotal evidence from the Andes indicates that some female farmers not personally holding water rights are generally not prevented from accessing irrigation water when they need it (Boelens and Zwarteveen, 2002). This has also been reported by case studies in different contexts; for example in South Asia (Zwarteveen and Neupane, 1995; Zwarteveen and Meinzen-Dick, 2001), Ethiopia (Ebato and Van Koppen, 2005) and Kenya (Adams et al., 1997). However, these women are constrained in developing informal mechanisms to access water, which sometimes work but sometimes do not, thus increasing their vulnerability and dependence on other people. Frequently, the amount of water and the opportunity of access does not cover their irrigation needs. In other cases, they are obliged to purchase water in informal water markets, often being exploited by paying high prices[7]. Independent property rights provide to women an important basis to secure production means, access to credit, extension services and information, and control over own incomes (Meinzen-Dick et al., 1997). However, this is not sufficient when marital and inheritance regimes remain gender-unequal (Deere et al., 2013).

It has been noticed that although women may use informal mechanisms for securing water for their needs, this is typically undertaken at a personal cost: insecure water rights, discrimination, physical risk or abusive agreements (Boelens and Zwarteveen, 2002). Unequal power relations involving water access affect not only some groups of women but also some groups of men, e.g. impoverished; landless; sick or disabled farmers (Boelens and Zwarteveen, 2002).

Security of access is also influenced by contextual conditions that include sector irrigation institutions, implementing organisations and water policies. These contextual factors influence gender exclusion and inclusion in water access and control in multiple ways. For instance, male

---

[7] Personal observations in rural areas of Afghanistan.

dominance in irrigation administration reinforces women's exclusion in water access and control (Chancellor, 2005; Zwarteveen, 2011). This issue not only affects women farmers but also female irrigation professionals. External irrigation and water management projects exert both a positive and negative influence on gender relations and water access. Some scholars have highlighted how external projects, in particular international cooperation, contribute to legitimising more equality in the roles for women as water users. Some examples are seen from Bolivia (Mehta et al., 2012); other Andean countries (Boelens and Zwarteveen, 2002); Sri Lanka (Aladuwaka and Momsen, 2010) and Rajasthan, India (Raha et al., 2013). However, Vera Delgado (2005) found external agents to have an incomplete understanding of local dynamics when designing and implementing water projects, which then exacerbates the concentration of project benefits for (certain) men.

2.3. Gender identities, roles and responsibilities in small-scale irrigation

Within the debates on gender and agriculture, 'traditional' gender roles emerge as socially *constructed* identities and a reflection of social relations, which determine 'the household tasks and types of employment socially assigned to women and men' (Momsen, 2010: 2). Therefore, gender identities must be understood from their political dimensions, where they serve to intervene in the dynamics of power within social relations (Cornwall et al., 2011). The seminal work of Esther Boserup (Boserup, 1970) was key in making the participation of women in production visible, and this had an important impact on subsequent development approaches. The multiple identities that rural women and men of developing countries carry have been traditionally oversimplified. While the feminist and gender scholarship has made successful efforts to broaden the simplified representation of rural women as 'victims' of patriarchal structures of power, the male farmer continues to be depicted using the attributes of *hegemonic* masculine identity (Cornwall et al., 2011), characteristic of patriarchal social systems.

In most rural areas in developing countries, irrigation-related activities are identified as male responsibilities. Male predominance in irrigation extends to the entire irrigation system, from design and planning, to scheduling, distribution, administration and actual use of the water resource for agriculture. Even though many women are farmers and base their livelihoods on crop production, women are not usually considered by their families or projects to be irrigators themselves (Bennett et al., 2005). This implies that water rights and the decision-making power over irrigation issues are mostly vested in men (Zwarteveen and Bennett, 2005). There is evidence that illustrates how women claiming participation in the male-dominated sector of water resource governance often have to confront culturally-rooted ideologies and power structures, often at a personal cost for them (for example Vera Delgado, 2005 in Peru; Giarracca and Del Pozo, 2005 in Argentina). Nevertheless, evidence indicates that a strict division of gender roles in irrigation may be misleading (Jackson, 1998; Bastidas, 2005; Chancellor, 2005).

Irrigation as a male domain may be partly explained by the traditional gender division of labour in agriculture with men being in charge of the more physically demanding jobs and those distant from the households, and women being responsible for lighter duties that mostly remain in the vicinity of the home (Momsen, 2010). As already discussed, water for agriculture is usually linked to land rights and land property, aspects where gender inequalities are persistent in many parts of the world. Poverty in rural areas is usually a reason for the involvement of many women in farming and irrigation, mostly in small-scale, family farms (Chancellor, 2005; Zwarteveen and Bennett, 2005). In some cultural settings, however, families tend to limit the involvement of women in agriculture by not allowing them to be seen farming. In other cases, women are indirectly restricted from farming through constraints on accessing resources for production, credit, technical assistance or markets (Chancellor, 2005). Cultural customs often prevent women from undertaking certain activities related to irrigation, such as furrow maintenance in traditional irrigation systems in Kenya (Adams et al., 1997).

Identifying men as being in sole charge of irrigation and the productive use of water leads to inadequate water project design and planning because it misrepresents the role of women in agriculture, irrigation and water governance. In many agricultural contexts today, common gender roles are changing and, in some places, quickly. The drivers of change are normally complex and context specific; for example, a 'feminisation' of agricultural activities can be evident (Radel et al., 2012; Pattnaik et al., 2018) while in other locations, this process is less clear (Palacios-Lopez et al., 2015). In addition, not all household members use water in the same way. Similarly, not all men have the same irrigation water needs (Chancellor, 2005). This includes crop and livestock production needs but also demand for construction of irrigation infrastructure. Women (and some men) have for a long time been excluded from water management planning, irrigation infrastructure design and irrigation information and training (Cleaver, 1998; Momsen, 2010). This can create problems by not allowing women access to a water source with their animals, or to being unable to cross a canal while carrying water or firewood (activities mostly performed by women and children). According to some authors, this gender segregation is partly explained by male domination in the engineering and irrigation profession (for example Zwarteveen, 2011).

It is worth noting here, that for the purpose of accurate gender analyses, the heterogeneity of the existing irrigation systems must be taken into consideration. Gender identities and patterns that are identified in traditional, small-scale or mountainous irrigation systems might differ from those found in larger scale, modern irrigation settings of commercial agricultural productions. A significant part of the scholarship on gender identities, roles and relations in irrigation describes traditional, village-level irrigation systems. Examples are: from the Andes, Bastidas (2005); Zwarteveen and Bennett (2005); Boelens and Zwarteveen (2002); from Central Asia, Bossenbroek and Zwarteveen (2014); from South Asia, Zwarteveen and Meinzen-Dick (2001); Zwarteveen and Neupane (1995); from southern Africa, Chancellor (2005). This raises the question of whether these patterns of gender roles in irrigation described for these traditional irrigation systems are also observed in modern or modernised irrigation settings?

2.4. Dynamics of gender participation in water governance

The global water decentralisation policy agenda has been questioned for mainstreaming and depoliticising the concept of participation (Dewan et al., 2014), when in fact dynamics of water users' representation and distribution of decision-making power are deeply political (Kemerink et al., 2013), and as such, usually problematic when social equality objectives are pursued. Social relations and traditions, cultural norms and structural inequalities are usually reproduced in (participatory) natural resource management organisations (Morales and Harris, 2014). As a result, social equity objectives, including gender equity, are hard to achieve or even questionable, as demonstrated by evidence from diverse geographies (see for example: Masanyiwa et al. (2014) in Tanzania; Zwarteveen et al. (2010) in Peru and Nepal; Agarwal (2001) in South Asia).

2.4.1. Participation and collective water governance

Participation of users in water management was adopted as a pillar of the decentralisation and restructuration processes in the irrigation water sector worldwide (Meinzen-Dick, 1997). There is a well-established literature on collective water management and the concept of participation is a cornerstone idea to understanding its effectiveness. The necessity to include farmers with decision-making power and capacity to define their own frames of rules and regulations in irrigation systems management has been well-documented to explain efficiency, sense of ownership of infrastructure, and financial and environmental sustainability (Tang and Ostrom, 1993; Ostrom, 2011; Senanayake et al., 2015). However, participation understood as a 'voluntary process' of equitable inclusion of voice and influence of all rural groups, among them many women and other traditionally disadvantaged groups, continues to produce mixed results (Saxena, 1998; Cornwall, 2003).

2.4.2. Adopting a participation typology for irrigation water governance for this study

Participation is understood in this research as 'a voluntary process by which people, including the disadvantaged (in income, gender, caste or education), influence or control the decisions that affect them.' (Saxena, 1998 reproduced in Cornwall 2011: 31). Participation takes different forms according to the two sets of elements of interest here: (a) the interest in participating and (b) the level of participation.

a. According to the interest in or the reasons for participating, White (1996) defined a frequently cited framework of participation, which includes four categories: nominal, instrumental, representative and transformative (Table 2.3). Each category is described by the top-down interest of organisations or projects, the bottom-up interest of participants or beneficiaries of projects, and the function or instrumental use of participation. In practice, these forms will overlap as people involved in projects may have a 'mix of interests which change over time' (White, 1996: 8). The interest of people in participating, and the interest of those holding power in having beneficiaries participate may not necessarily converge (White, 1996). This framework is useful at highlighting that some degrees of participation do not necessarily imply challenging structural local power relations. It is based on the need to improve conditions of unequal participation and effects on individuals, but does not describe 'intra-group' dynamics of participation (Agarwal, 2015).

Table 2.3 Forms of participation according to the interest in participating

Form of participation	Top-down	Bottom-up	Function
Nominal	Legitimation	Inclusion	Display
Instrumental	Efficiency	Cost	Means
Representative	Sustainability	Leverage	Voice
Transformative	Empowerment	Empowerment	Means/end

Source: White (1996) in Cornwall (2011).

b. According to the level of participation of people in organisations, Agarwal (2001) defined six forms of participation: nominal, passive, consultative, activity-specific, active, and interactive (Table 2.4). According to this framework, participation is considered 'effective' if it goes beyond nominal participation, i.e. when members of an organisation attend meetings, have a voice and influence decisions (Agarwal, 2001). This typology considers forms of participation in relation to dynamics within the groups; however, 'effectiveness' of participation may be difficult to assess and quantify.

Table 2.4 Forms of participation according to the level of participation

Form/level of participation	Characteristic features
Nominal	Being only a member of the group.
Passive	Accessing information about decisions when already made; presence in meetings but no voice.
Consultative	Providing opinion with or without influencing decision making.
Activity-specific	Taking part in determined tasks.
Active	Expressing opinions and having initiative in certain issues.
Interactive (empowering)	Exercising voice and having influence in the group's decision; holding positions as office bearers.

Source: Typology presented by Agarwal (2001) and modified by Agarwal (2010).

To explore the mechanisms of participation of water users in water resource management, the study will use an adapted typology (Table 2.5) that includes elements of the Agarwal typology of participation and uses them according to the degree in which participants exercise their rights and voice (Arnstein, 1969; Cornwall, 2003) and the degree of fulfilment of their shared responsibilities within the organisation.

Table 2.5 Adapted typology of participation in irrigation self-governance according to rules of entry to WUAs

Rules of entry to WUAs	Type of participation	Characteristics of participants
Non-water right holder (non-registered member)	Non-authorised water user	Use of a common water resource without agreement of community of users.
	Authorised water user	Operational right to use the resource, granted by family relationships, tenancy or sharecropping arrangements.
Water right holder (registered member)	Nominal	Water right owner; no exercise of collective rights and obligations.
	Minimum	Minimum exercise of collective rights and obligations to avoid losing the water right, e.g. payment of water fees.
	Passive	Limited exercise of collective rights and obligations, voice or influence in decisions is not guaranteed.
	Activity-specific	Partial exercise of collective rights and obligations; no official positions held.
	Interactive	Full exercise of collective rights and obligations, with influence on relevant decisions; management positions held.
	Transformative (leadership)	Full exercise of collective rights and obligations; leadership position held with full decision-making power.

Source: Adapted by the author based on Agarwal (2010) and (White, 1996).

To apply this typology to irrigation management, water rights were used as inclusion and exclusion factors. In addition, and for the specific application to WUAs, elements describing degrees of participation were considered:

- Membership in the WUAs: determined by access to land and water rights;
- Attendance at associations' meetings;
- Fee contribution;
- Labour contribution;
- Representation in association committees;
- Voting;
- Holding of officer positions (support or assistance positions with limited decision-making power);
- Holding of leadership positions (greater decision-making power).

This adapted typology includes leadership as a type of participation with transformative effect; that is, having the potential to 'empower' participants (White, 1996). The use of a typology that describes forms and levels of participation in water governance, and that also reflects social relations and results of participation, is useful to describe changing social interactions due to changing patterns of participation of different groups of men and women.

2.4.3. Factors and mechanisms of gender participation in WUAs

The participation of women in water governance structures -as well as in other community participation organisations- is shaped by four intertwined sets of factors: personal factors and attributes; contextual dynamics of social relations including gender relations; institutional governance factors (Sultana, 2009; Agarwal, 2010; Raha et al., 2013; Masanyiwa et al., 2014) and the interactions between physical characteristics of the resource ('nature') and the society (Sultana, 2009). Certain groups of resource users may experience 'participatory exclusions' (Agarwal, 2001). Thus, while women being included in more equitable numbers and forms could result in them becoming 'empowered', less advantaged women may be disproportionally affected by participatory exclusions (Agarwal, 2001).

Historically, barriers to participation such as rules of entry, intrinsic social stratifications and customary norms have resulted in low participation of women in WUAs (for example in the Andes, Bastidas, 2005; and in South Asia, Meinzen-Dick and Zwarteveen, 1998). This happens even in those cases in which women have a prominent role in agriculture and irrigation. For example, in a participatory soil conservation and irrigation project in the Andes in Peru, the exclusion of women from the project was assumed as normal[8], even though they were also farming (Vera Delgado, 2005). In a case study in Rajasthan, India, Raha et al. (2013) mention that women have traditionally not been considered farmers in their own right, and consequently, not fully included in watershed committees. However, Zwarteveen et al. (2010) question the *a priori* assumption that women are excluded from water management because of their low participation in WUAs. The authors base their argument mainly on two aspects. First, they argue that WUAs are not critical for water management and that informal venues may be more important. Second, they suggest that women may benefit from their invisibility and apparently relegated role in water management, in terms of having some control over irrigation with lower financial or social pressure. At the same time, they consider that women may take a greater stake in decision making regarding water issues than what it is apparent from simply observing their participation in formal WUAs (Zwarteveen et al., 2010). Nevertheless, the fact that women share a varying amount of 'informal' decision-making power does not make formalisation of

8 Only household heads were called to consultations and most of them were men. Women were excluded from water user's organisations because they did not fulfil entrance requisites: land rights were in the name of men and therefore, water rights, too (Vera Delgado, 2005). There is a generalised conception that intra-household social relations in the Andes are harmonious and gender division of roles is fair and cooperative. For discussion on this see Boelens and Zwarteveen (2002).

their rights, voice and representation less necessary if the goals are to promote social equality and a fair regard for women's work.

Motivations of women to participate in natural resource management associations (e.g. attend meetings and speak up) can have multiple reasons. However, severity of resource constraints has been observed as one of the most influential factors for women to participate and voice their claims regardless of cultural setting. For example, conflict of interest in an irrigation project affecting water provision to livestock managed by women in Llullucha, Peru, and abusive water tariffs in Tucumán, Argentina, and in Cochabamba, Bolivia, triggered the participation of women in water resource management despite various forms of women's exclusions (Bennett et al., 2008). As a result, the voice of women and their actions caused important changes in the irrigation project design in Peru and in the drinking water pricing in Argentina and Bolivia. Empirical evidence from forest users' associations in India and Nepal indicated that landless women or women constrained by resource availability to support their livelihoods or domestic tasks tended to attend more and voice their problems more clearly (Agarwal, 2010). The level of pressure to find solutions to critical survival challenges appears to overtake traditional barriers to women's participation.

Other factors related to women's participation in community organisations are highly dependent on local conditions and household characteristics. Gender distribution of household work and women's high workloads are extensively recognised factors constraining the participation of women in community activities (Moser, 1993; Momsen, 2010). While within the gender and development practice it is frequently assumed that women do not have time for meetings, there is evidence that women manage to prioritise tasks and delegate household responsibilities in order to take part in activities in which they have a strong interest (for example: Agarwal, 2010; Masanyiwa et al., 2014). On the other hand, there is also evidence that participation in community activities related to water management can be linked to the type of household obligations women have according to their life cycle (e.g. childbearing) (Bastidas, 2005), and it usually involves a third layer of work burden on women (Moser, 1992; Raha et al., 2013). In South Asia, Agarwal (2010) observed that older women with less family obligations tended to attend more forestry communal meetings, while in Ecuador, this was not the case in WUAs (Bastidas, 2005). The age of women was found to be a factor in decision making capacity: opinions of older women were influential when speaking up in community meetings in South Asia (Agarwal, 2010) and in Tanzania (Masanyiwa et al., 2014). While some case studies indicate that many rural women ('village women') find it difficult to speak up in public due to customary norms or because they are shy (especially if they are non-formally educated) (Bastidas, 2005; Vera Delgado, 2005; Raha et al., 2013). Agarwal (2010) found that female illiteracy was not a constraint for some women to speak up in committee meetings, especially when serious resource problems needed to be addressed. Other factors may take effect in either direction, such as the economic condition of the water user; land ownership and male-migration. Inconvenient times and locations of the meetings are also mentioned in gender analyses as factors leading to the exclusion of women from meetings (for example, Lefore et al., 2017).

Institutions of irrigation administration, enforcement organisations and water policies influence gender participation in diverse forms. Decision making concentrated on certain groups of men is frequently underpinned by institutional approaches and donors' demands (Chancellor, 2005). Set-ups and power relations affect participation not only of women but also of many men. Requirements of being affiliated to political parties, having kinship or financial influence and specific ethnic or race backgrounds are important factors of inclusion/exclusion from participatory institutions (Agarwal, 1994; 2010; Masanyiwa et al., 2014). Importantly, the presence of an influential leader of the organisation can be a key factor in promoting the participation of women, or, in preventing not only female, but also male members from speaking up (Agarwal, 2010).

2.4.4. Opportunities and conditions for increased participation of women in governance

The increase in women's participation in water resource management is critically important for a broad range of development aspects including: equity, poverty reduction, and more rational design and implementation of water projects. Toward this end, important questions arise. Does more participation of women in WUAs actually help to address the water needs and interests of women? Does such increased participation secure their access to and control of water when being more involved in WUAs? (Zwarteveen et al., 2010). What are the opportunities and conditions for collaborative involvement of women in water governance structures? Research on these issues is a substantial part of this study and will be specifically addressed in Chapter 8.

In order to understand changes in the forms and levels of participation, it is helpful to characterise the mechanisms of women's and men's participation. In this regard, quantifications that measure only the number of participants attending a meeting or being hired as labour in a water project do not describe who is included and excluded or what mechanisms are involved (Taddei, 2011). By contrast, participation assessments that focus on processes and dynamics of participation provide nuanced descriptions of the nature of women's involvement. Scholarly attempts to empirically characterise participation in natural resource management and water governance offer interesting insights for the analysis intended in this project research.

In a study of gendered participation in communal forest institutions in Nepal and India, Agarwal (2010) measured three aspects of 'effective' participation in the executive committees (EC) of decentralised forest user groups: (a) number of women attending EC meetings, (b) number of women speaking up at meetings, and (c) number of women holding positions as officers. Agarwal measured the effect of the number of women participating in terms of their proportional strength relative to men. The author also searched for a critical mass effect by testing whether the percentage of women in the group determined the likelihood for a woman to attend the meeting. Generally, women were found attending meetings in much lower proportions than men, even though they were nominal members of the executive committees. Agarwal found that more women attended meetings, spoke up[9] and held office positions in executive committees in associations with a higher number of female members (more than two women in committees in associations with an average of 11-13 female members). In the case of women's rate of attendance, the range of 25-33% of the members being women significantly increased the number of women attending a meeting[10]. Therefore, a threshold effect could have an influence. Agarwal concluded that the popular 'one-third' minimum of women's proportion usually recommended for reaching critical mass in meetings and organisations has statistical significance, although it is not sufficient in terms of equality (Agarwal, 2015).

In regard to the probability of women holding office positions, a higher number of women members of the EC had a positive effect; however, it was not sufficient to result in a higher number of women in office (Agarwal, 2010). Although this result supports the generalised policy of including a mandatory minimum percentage of women in office positions, there are other factors that condition the roles and decision-making power of those women in office. Cultural restrictions are strongly influential. In India, where customary rules are more stringent

9 By asking women and men about how many women spoke in the previous three meetings (none, some or most) (Agarwal, 2010).

10 Beyond that range, thus ECs with higher number of female members, the proportions of women actually attending meetings tended to decline, possibly because more women attending was not seen as more useful (Agarwal, 2010).

than in Nepal, very few women were found to be office holders. In the rare cases were women did hold office, it was due to the influence of a local NGO. On the other hand, more flexible cultural norms in Nepal allowed a higher number of women to become office holders but in much lower numbers than men and rarely in leadership positions.

Observations of Masanyiwa et al. (2014) in water and health service delivery in Tanzania indicate that women are more commonly found holding positions that relate to their 'practical needs' (e.g. domestic duties, health, sanitation, children's education) or that are culturally accepted as feminine. Illiteracy appears to have an effect on preventing women from holding official positions and speaking up in public (Agarwal, 2010; Masanyiwa et al., 2014). These studies do not clarify whether holding such positions influences relevant decision-making processes in these participatory venues. Is there an impact of more women holding official positions in increasing the share of decision-making power? If so, which is the effect in the share of benefits? Who benefits and who does not? What are the necessary conditions to support more women holding leadership positions without the risk of deepening inequalities between groups of women? In addition, consolidation of women's participation and genuine 'agency', especially in absence of external support should be a subject of further investigation.

Other studies have characterised women's participation by focusing on the dynamics of participation in women-only organisations that have proved to effectively benefit women's interests. A convenient and less distressing way for women's participation, very popular in India, has been the creation of women-only self-help groups. These women-only groups are recognised as successful particularly in India because they allow women to enjoy spaces and activities of their own interest and identity (for water resource management see for example Raha et al., 2013), and probably because stringent customary (patriarchal) social structures and social hierarchies are not challenged. A similar women-only model is reported to have worked well in a community drinking water project in Sri Lanka (Aladuwaka and Momsen, 2010). In order to increase women's participation in water governance, Raha et al. (2013) observed that a double-track approach is useful, where the integration of both men and women in project activities and women-only activities might enhance the participation of women in policy and practice of water governance. However, the feasibility and usefulness of such a double-track approach must be culturally dependent and a close look at whether this model may work in locations other where it was first described is necessary. Opportunities of increasing women's participation in resource management are also found in linking collective resource management groups with strong women organisations through the creation of strategic networks such as federations (Agarwal, 2015).

2.5. Conceptual framework

Understanding the mechanisms that determine and govern gender identities, gender roles and division of labour, and social relations of gender is of particular relevance for explaining how natural resource management, including of water, is gendered. After examining the water governance and gender debates, the study will next develop an integrative framework for better conceptualisation of research geared toward understanding irrigation systems, practices and processes, especially in relation to gender equality in water governance. This section therefore provides a detailed account of the constructed framework components, including how it is informed by feminist, ecological and sociological theories. To complement understanding of the motivations and needs for developing this conceptual framework, Chapter 5 presents an application of the conceptual framework, specifically used as an integrative gender-analytical approach. This has been undertaken in order to test the operationalisation of this new analytical approach.

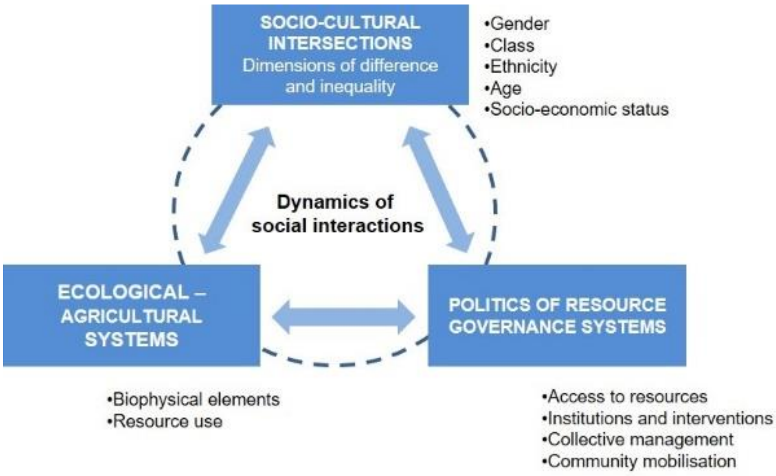
2.5.1. The analytical elements of the conceptual framework

The conceptual framework developed and used for this research aims to make visible two aspects that have received only partial attention in the literature about women, gender and irrigation: 1) the intersections between 'technical' irrigation practices and practices derived from social interactions in collective irrigation water governance, in particular, gender roles and relations, and 2) the effects of those dynamics of social interactions and irrigation practices in livelihood strategies within the context of the current leading global water governance policies. The construction of the conceptual framework brought together three theoretical approaches: the feminist political ecology (FPE), the social-ecological system (SES) framework, and the social relations framework. These perspectives are outlined below.

Using a feminist political ecology approach

The feminist political ecology (FPE) framework understands all social relations, including gender, as determinant variables explaining local and global ecological processes, 'economic change' and development of both, men and women (Rocheleau et al., 1996). The FPE framework is useful to show how environmental policies and practices are influenced and defined by a social, economic and political balance of power (Rocheleau et al., 1996; Elmhirst, 2015). In the last two to three decades, scholarship on FPE has been expanding at various levels including: dimensions of difference that intersect gender with other social characteristics such as ethnicity, race, poverty, or 'coloniality' (Harris, 2015c: xx); legal frameworks for property rights (Vaz-Jones, 2018) in increasingly complex environmental contexts of degradation, depletion of natural resources, climate change (Harris, 2015c), and global socio-economic contexts such as massive migration movements (Momsen, 2017). Issues of subjective positions and relations of water, people, emotions and geographies are also emerging in the FPE scholarship (Sultana, 2011; Hanson and Buechler, 2015). Likewise, thematic expansion includes production systems based not only on management of natural resources but also of agricultural systems (for example, Buechler, 2015), multiple scales of analysis (Nightingale, 2015) and issues of resource governance (Adams et al., 2018). The expansion into those research areas show robustness of the FPE (Harris, 2015c) to contribute to a sound analysis of current critical development and environmental matters. Figure 2.2 shows an extended FPE framework for an irrigation system collectively managed by different users. This can be conceptualised as an interconnected arrangement of socio-cultural intersections, ecological-agricultural systems and governance arrangements.

Figure 2.2 An extended feminist political ecology (FPE) conceptual approach



Source: Adapted by the author based on conceptual expansions of the FPE (Buechler and Hanson, 2015; Harris, 2015b).

Using a social-ecological systems approach

However, critiques of the FPE framework argue that it lacks sufficient balance between the three main elements of the FPE framework -*feminism*, *politics* and *ecology*, both conceptually (Najjar, 2015) and methodologically (Hanson and Buechler, 2015). To introduce robustness to the 'ecology' dimension of the FPE framework, the expanded FPE perspective is combined with the conceptualisation of a communal irrigation system as a social-ecological system (SES)[11]. The variables and attributes (Ostrom, 2007) of any water resource system are combined and arranged in order to make water accessible and available for production (Beccar et al., 2002). These arrangements give rise to dynamic and complex interrelationships within and outside a given agricultural system, and are shaped by social, political and environmental contexts across time and scales (Molden, 2007).[12]

Useful here is the definition of SES by Anderies et al. (2004: 6) as 'the subset of social systems in which some of the interdependent relationships among humans are mediated through interacting biophysical and non-human biological units', resulting in complex systems of multiple subsystems and larger systems. Building upon this reasoning, Ostrom (2007: 15181) argues that the problems related to 'complex, multivariable, non-linear, cross-scale, and

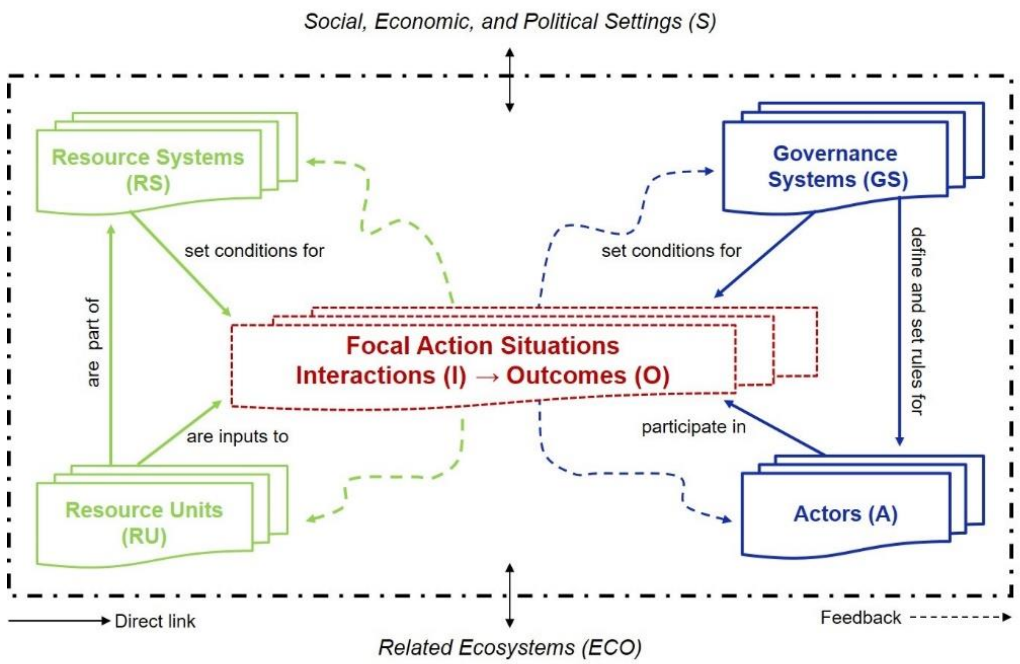
11 The linkage between FPE and SES frameworks is described as useful, by Buechler (2015), for examining interactions between activities performed by gender and ecological systems.

12 The extensive scholarship on common-pool resources has significantly contributed to understanding those arrangements; for examples, see Agrawal (2001) and Ostrom (2011).

changing SESs' can only be detected and analysed through methods or models that go beyond simplistic 'panaceas'. Ostrom (2007); (2009) proposed a 'diagnostic method' that reflects complexity by organising variables into a 'nested, multitier framework', later updated (McGinnis and Ostrom, 2014) to allow researchers to study a range of variables organised in tiers at different levels as shown in Figure 2.3. Also useful is the fact that each of the described variables can be further unpacked into multiple conceptual tiers. As not all variables in a sub-system are relevant in analysing a given SES, and they function as 'partially decomposable systems' (McGinnis and Ostrom, 2014), the framework allows sufficient flexibility to analyse any natural resource system.

The incorporation of the diagnostic method in the development of the conceptual framework for this present study is helpful to more accurately understand and describe the complex structure(s) of governance systems and their problems. This 'operational' feature is missing in the FPE framework.

Figure 2.3 Revised SES framework with multiple first-tier components



Source: McGinnis and Ostrom (2014) (permission granted by the first author).

Ostrom (2011) acknowledged the need to examine 'human actions' within the functioning of SESs. For example, she suggested that interactions and outcomes of SESs may result in increasing or decreasing 'trust' social relations with effects on the functioning of the resource system. However, it is acknowledged that a comprehensive analysis of social relations of power is missing within the Ostrom SES approach (Fabinyi et al., 2014); in particular, considerations of gender differences in the use and management of resource systems (Łapniewska, 2016).

By contrast, a conceptual framework for investigating gendered outcomes in natural resource governance like the one proposed in this study, requires elements that broaden the understanding of *who* accesses and uses the resources and *how*, by examining the configurations of social relations of power as a core element of the framework. This consideration is remarkably important to make the analysis more realistic in terms of revealing inequalities based on gender and other socio-cultural attributes in contrast to 'depoliticised' approaches (De Boer et al., 2013) and ideologies of institutional neutrality (Kabeer, 1994). While feminist political ecology (FPE) has opened relevant perspectives for more complete and realistic analyses of gender and other social differences in NRM, its operational application remains challenging.

Using a social relations framework

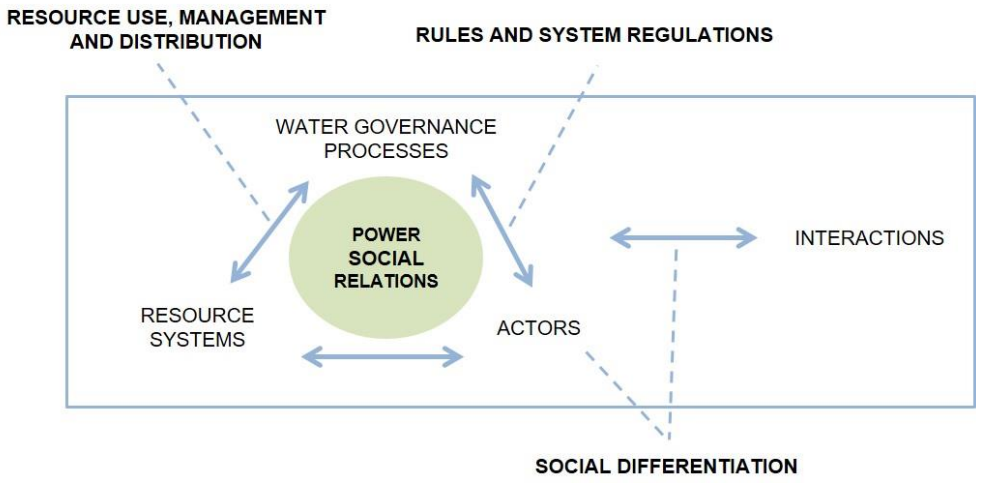
In order to address the limitations outlined above, three useful elements of the social relations framework (Kabeer, 1994; Kabeer and Subrahmanian, 1996) are drawn upon and connected to the combined expanded FPE and SES frameworks. These are (1) social relations between people, (2) relationships of people to resources and activities, and (3) configurations of those relationships and institutions. These concepts are part of the so-called 'institutional analysis' proposed by the social relations approach (March et al., 1999) and have been incorporated to define categories to approach the analysis. Thus the incorporation of these conceptual elements provides a method of analysis of the issues of power derived from institutions (e.g., state, community, household, market) and their activities (Kabeer, 1994), and how they shape power relations.

Social identities, roles, responsibilities, rights and control over one's self and others are understood as originating from social relations (March et al., 1999). Social relations of gender determine social hierarchies not only between men and women, but also between same sex individuals, both within the sphere of the family and household, and also outside in interactions with society (Agarwal, 1994). The social relations approach is therefore helpful to systematically incorporate the ideas of gender (in)equality and the autonomy of individuals (in particular women) as agents of their own development as core concepts (March et al., 1999). This provides a more nuanced and structured understanding of the governance processes and the gendered implications, and allows the operationalisation of the approach. These analytical and methodological elements are not sufficiently unpacked in the FPE.

The notion that gender identities, roles and relations are 'socially constructed' and therefore not immutable has been widely adopted within gender and development scholarship. It is also a core concept of the conceptual framework proposed in this study. Dynamics of gender relations are shaped, even modified by different factors including: access and control of resources and bargaining power (Agarwal, 1994; 1997); constraints imposed by family relationships, commonly expressed as patriarchal models (Kabeer, 2011); balance of power and 'ability to exercise choice', i.e., agency (Kabeer, 1999); gender awareness (Kabeer and Subrahmanian, 1996); development policies and their influence in modifying the balance of power between women and men (Momsen, 2010), and different governance structures (Kabeer and Subrahmanian, 1996) and governance outcomes (Cleaver and Hamada, 2010).

Therefore, the development of an integrative gender analysis of natural resource management requires the incorporation of the dynamics of social relations as an intrinsic element of the SES *filtering* and/or *catalysing* the SES processes. In so doing, a number of overarching interactions emerge (Figure 2.4): *resource use, management and distribution*; *rules and system regulations*, and *social differentiation*.

Figure 2.4 Resulting interactions of an irrigation governance system driven by dynamics of social relations of gender

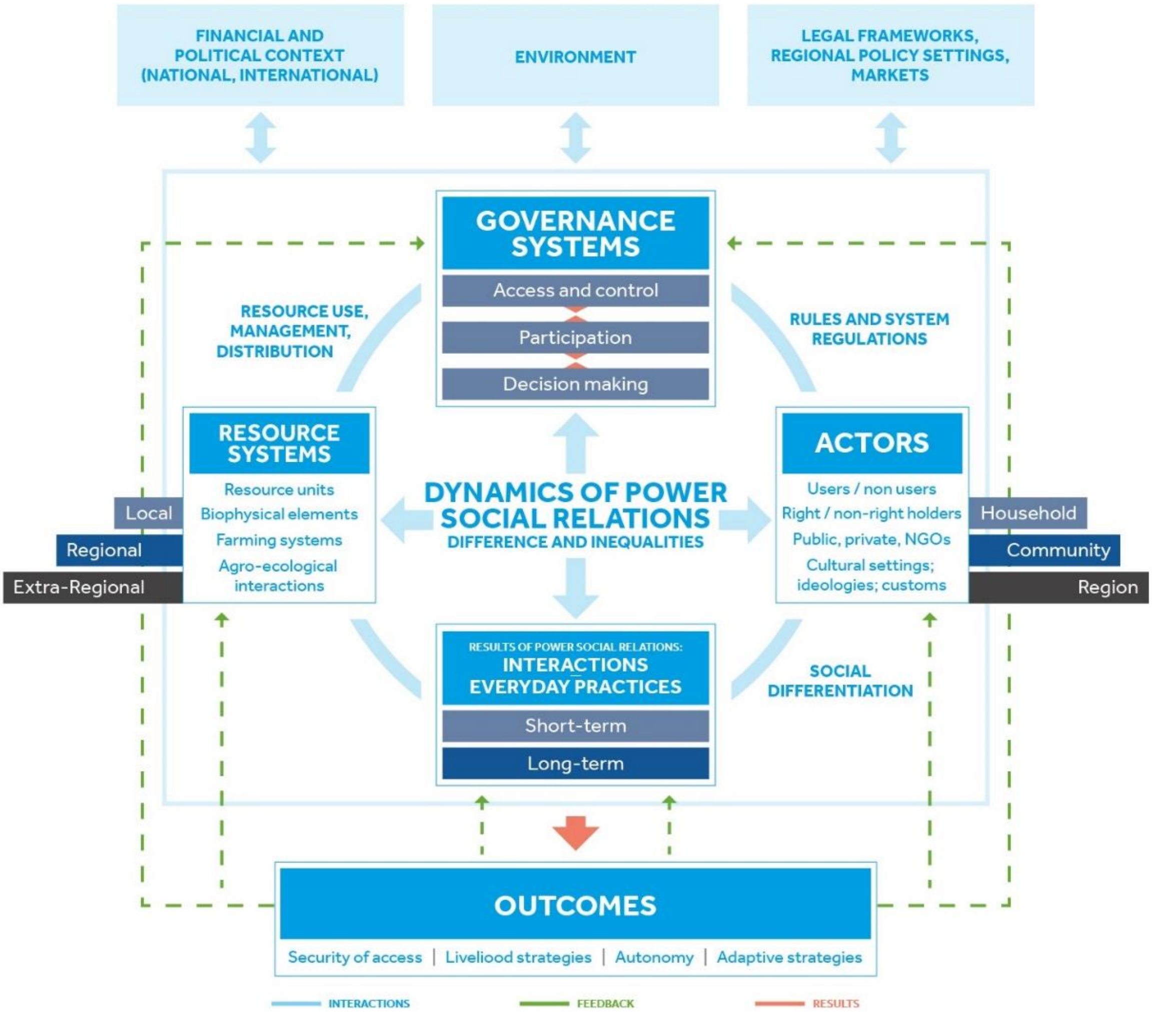


Source: Developed by the author.

2.5.2. The integrative analytical approach to water governance

By combining the above discussed elements of the expanded FPE, SES and social relations approaches, the conceptual framework (as illustrated in Figure 2.5 below) for examining the dynamics of social relations driving the processes and outcomes of NRM governance is established. An account of the framework's components and application will be presented in Chapter 5.

Figure 2.5 An integrative gender-analytical framework to natural resource governance



Source: Developed by the author.

In the application of the above conceptual framework, three key variables of resource governance are emphasised: access and control through property rights; participation in institutions of collective resource use, e.g., water users' associations (WUA), and decision-making regarding management practices. The resource systems (e.g., communal SSIS) are self-governed by diverse types of actors that include female and male farmers, who hold diverse land tenure rights. In the case of irrigation systems, other relevant actors are water- and agriculture-sector officials, and the private sector (e.g., agro-chemical and agricultural service providers). These actors interact, producing certain dynamics of social relations of power. The dynamics of interrelations include a number of overarching interactions (i.e., resource use, management and distribution; rules and system regulation; and social differentiation). The interactions materialise in 'routine practices' or everyday activities (Kabeer, 1994), which respond to physical, emotional and affective experiences (Harris, 2015a).

In combination these elements produce *governance outcomes* that synthesise the core elements of the functioning of the governance system(s) (see bottom of Figure 2.5): the functioning of the resource systems studied results in certain degrees of *security of access* that in turn allows *securing livelihood strategies* and *autonomy* (capacity to make informed, own decisions) for resource users. In addition, in a context of resource shortages, such as water scarcity and increasing unpredictability due to climate change, certain *adaptive strategies* are used by farmers to protect their wellbeing or at least, their survival.

In an iterative process, dynamics of social relations define and shape formal and informal rules and regulations of the governance systems; drive actors' behaviour and the actual way that resources are used and allocated. At a given point in time and space, outcomes will provide feedback to the other elements of the resource governance framework, which will trigger re-arrangements within the combined systems. In addition, contextual elements external to the system namely overarching legal frameworks; financial and political settings; markets and environment will influence.

2.6. Conclusions of the literature review chapter

By understanding the mechanisms that determine and govern gender identities, it can be shown how gender roles and division of labour, and social relations of gender, are of particular relevance when trying to understand better how natural resource management, including of water, is gendered. Understanding gendered social relations and property rights is critical for a robust analysis of natural resource management, including: access to and control of resources; resource use rationale, and livelihoods outcomes for all groups of users. In the context of access to, and use of, irrigation for this study, equality has been used to refer to equal opportunity to resource entitlements and equal share of benefits and responsibilities among users' right holders.

One of the core elements of this study is to understand how access to and control of resources, water, decision making and participation in water governance are shaped by the arrangements of power in social relations of gender. What are the effects and outcomes on water governance? Who benefits and who loses? The study explored issues of gender relations through two critical perspectives. One relates to the fact that gendered social relations intersect with other forms of social relations (e.g., of class, status, age, socio-cultural background). The second encompasses a full 'political' notion in the sense that social relations of gender are subordinated to diverse arrangements of power. It is on the basis of these perspectives that the study has examined women's and men's identities; the way they interact to build their livelihoods and their abilities to make choices that can be assessed against 'equality' and 'autonomy'.

From these premises, and in reviewing analytical approaches for this investigation, it becomes clear that there is a need for a comprehensive and theoretically robust framework that captures a holistic view of the complex interactions inherent to the operation and governance of natural resources, including irrigation systems. This study has addressed this issue through an integrative conceptual framework based on three theoretical approaches: feminist political ecology, social-ecological systems and social relation frameworks. A review of existing theoretical approaches and an outline of the conceptual framework was presented in this chapter, and will be further explored, alongside an example of its application, in Chapter 5.

Analysing gender roles in agriculture provides a basis for understanding gender roles in irrigation. The relationship between women and water has been recognised as being primarily linked to domestic use of water in consumption, hygiene and sanitation. In most rural areas in developing countries, irrigation-related activities are still identified as male responsibilities. The male predominance in irrigation extends to the entire irrigation system, from design and planning, to scheduling, distribution, administration and actual use of the water resource for agriculture. Irrigation as a male domain may be partly explained by the traditional gender division of labour in agriculture. Water for agriculture is usually linked to land rights and land property, aspects where gender inequalities are persistent in many parts of the world.

An important interest for this study is to empirically explore the strategies or mechanisms (formal and informal) different groups of women and men develop to gain access to and control over irrigation water across different cultures and socio-economic settings. Moreover, the study aims to elucidate whether it is possible to find similar gender patterns in water access, control and participation in management in contrasting settings. If uniform patterns exist, water policy that more effectively addresses the serious consequences of gender inequality in this field can be advanced. For example, secure land right tenure can reduce the vulnerability of women in cases of ‘economic hardship, divorce, or widowhood’, as well as ‘strengthen their bargaining power within the household’ (Lastarria-Cornhiel et al., 2014) and this is a powerful policy justification for secure land rights for women. Is there then robust evidence to justify such policy interventions in the water sector policy and practice? If there is, which mechanisms and factors of gendered social relations should be considered when developing irrigation intervention frameworks? These are questions this study will explore further, particularly in Chapter 6.

The review of the scholarship on small-scale irrigation management, WUAs and gender has contextualised how water governance institutions influence access to water, formal water rights and decision-making power for smallholders (usually groups of farmers with less power and voice, and particularly women). A gap in this scholarship was identified: a holistic analysis approach is needed to better understand how the functioning of WUAs affects livelihood process and equality. These themes will be addressed in Chapter 7.

Throughout the review of the literature on gender, water rights and irrigation management, the central question remains: to what extent has the inclusion of gender equality policies played a role in improving the issues derived from discriminatory gender patterns in resource access and management? This will be examined in Chapters 5 and 6, at the water users’ scale; in Chapter 7 at the WUAs’ scale and in Chapter 8 in regards to women in WUA leadership.

Finally, the review makes transparent the academic need for further investigation of the specific effects of changing patterns of women’s participation and decision making in local water resource management, in particular, the aspects that change when women undertake the leadership of local water management institutions. This will be further addressed in Chapter 8, as well as the constraints and opportunities to increase the involvement of women in management and leadership.

3. Research Methodology

3.1. Introduction

A study of patterns of social differentiation, gender issues and water in small-scale farming benefits from diversity of data, methods and perspectives. In this research, diversity was pursued through two main approaches: first, designing a multicase study in two countries, and second, by selecting a mixed-method research approach. This research strategy proved helpful in capturing a broad variety of aspects with relatively high detail from two very different countries. It allowed to systematically collect and analyse qualitative and quantitative data. This chapter describes the research approach and analytical procedures used. Considerations of research ethics, fieldwork challenges and measures to overcome those challenges are also detailed here.

3.2. The research approach

The research was conducted as a comparative, trans-regional study in which issues of gender roles and relations in irrigation water governance were analysed. The goal was to compare their manifestations, similarities and differences in diverse socio-economic and cultural settings (Bryman, 2012). In order to ensure sufficient diversity in an empirical study, a multiple case design with cases from two countries was used. The fieldwork was conducted in two countries characterised by widely contrasting cultural and socio-economic backgrounds: *Ethiopia* and *Argentina*. The multicase (Merriam, 2009) or multiple-case study design (Yin, 2003) by definition involves the analysis of more than one case study. This allows general understandings of the issues under investigation despite the specificities of the particular case studies included and the diversity of their contextual characteristics (Yin, 2003).

The generation of knowledge (epistemology) for this research followed a pragmatic position due to the professional and personal concerns of the author regarding the applicability of research outcomes and 'solutions to problems' (Creswell, 2013). The 'agronomical-technical' nature of the problem of irrigation needs to be contextualised with an understanding of the socio-economic and political contexts that govern participation and decisions in water governance and in agriculture. An in-depth understanding of the 'real-life context' (Yin, 2003: 13) was significant for this investigation, particularly for an appropriate understanding of processes within cases and patterns across cases. In order to complement the qualitative analysis of the cases, a survey was used to contextualise the variables and factors identified as most relevant. Dynamics of social relations in water governance were explored using in-depth (qualitative) interviews, focus group discussions and direct observations in all the research sites. Patterns, trends and differences were analysed in the context of each study site. Subsequently, results from the two research locations were jointly interpreted.

3.3. Data collection and research methods

The study collected data combining the following research methods:

a) Compilation of site/system descriptive data

In the two locations selected, there is an important amount of background information available (secondary information): technical aspects regarding crop production, livelihood strategies, hydrological studies and irrigation as well as demographic and socio-economic databases that was revised to contextualise the research project (Chapter 4 Context).

b) Semi-structured interviews

The semi-structured interview is a method used frequently in qualitative research. Semi-structured interviews allow an open response from the respondent, gather deep information on the topic, including experiences, perceptions, obtain emotions and capture intentions and value statements from the interviewed person; they have an informal or conversational nature and are usually flexible enough to be combined with other methods of research (Longhurst, 2003). The following semi-structured interview types where conducted:

- *Individual interviews:*
    - In-depth semi-structured interviews to key informants from the irrigation and agricultural sectors in each location. Its structure varied according to the expertise of respondents. An example of this research tool is presented in Appendix 8.
    - In-depth, semi-structured interviews to WUA members and leaders. Wherever possible, the questionnaire was administered separately to female and male participants. An example of this research tool is presented in Appendix 9.
- *Group interviews:*
    - Semi-structured focus group discussions (FGD). The aim of using this method was to obtain a comprehensive exchange of views, experiences and ideas in a relatively short

amount of time. At the same time, this method met other objectives: to triangulate and validate information and to evince social interactions (Appendices 10 and 11).

c) *Survey of water users organised in water users' associations*

A cross-sectional survey (data collected at one point in time) was conducted in order to obtain a quantitative description of the variables under study (Creswell, 2013), to gather information regarding opinions, attitudes, behaviour and social interactions among participants (Biemer and Lyberg, 2003; Clifford and Valentine, 2003). A survey instrument (structured questionnaire) specifically designed for this study was created and administered in face to face interviews. Mostly closed questions, but also a small number of open-ended questions were included. The survey was prepared in English and in Spanish. The English version of the questionnaire (Appendix 12) was piloted in Raya Valley, Ethiopia, the first field data collection site. It was next translated to the local language of Tigray (*Tigrigna*). The Spanish version of the questionnaire (Appendix 13) was piloted in Mendoza, Argentina.

d) *Open interviews* to key informants and irrigation users. These conversations consisted of unstructured, usually spontaneous conversations relevant to specific research topics and generated during the fieldwork. These open interviews enriched the understanding of the contextual situation of respondents, and/or provided helpful pieces of evidence.

e) *Direct observations of (a) household and farm-field activities and (b) community events related to irrigation and agricultural activities,* including informal open-ending conversations with visits to the respondents' own settings, to obtain information and to create trust and mutual understanding. Direct observations were gathered by the researcher in events related to water use and management; farmer's daily activities and/or extension officers' routine tasks. These data were gathered in the form of notes in a field notebook, and as photographs and short videos. A written 'observational protocol' was used for demographic information, which included location, date, coding of the image, audio and video recordings, and reference code of the informant (Creswell, 2013). The richness, variety and format of observational data varied according to the different research locations.

The questionnaires for the survey and semi-structured interviews were developed after the reconnaissance visits in the research areas (Mendoza and Tigray) during July and August, 2015. These research tools were later adjusted after the implementation of a pilot study in the field (see Figure 3.6 for a description of the implementation sequence).

The research population of the study included: a) female and male farmers who practiced irrigated small-scale agriculture as primary livelihood strategy and belonged to local irrigation governance organisations; and b) key informants from the regional and local agricultural, water resource management, and research and extension administration sectors.

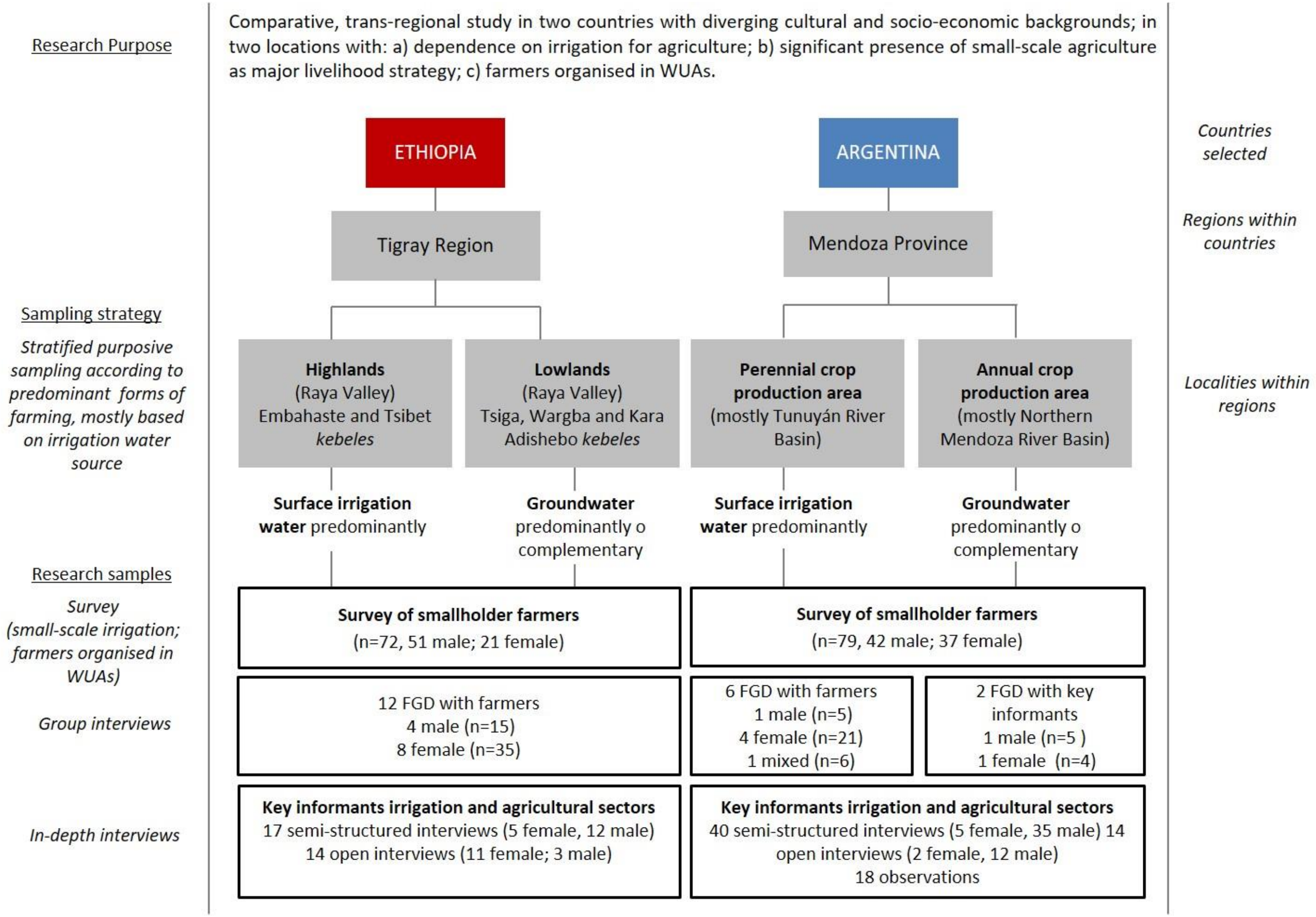
3.4. Research design and methodology

According to the research approach selected for this study, a number of different methods were used to understand the research problems from different perspectives: a survey (quantitative approach), and a set of in-depth interviews and focus group discussions with a wide range of relevant informants (qualitative approach) were conducted in both countries. Data collection included gathering secondary information in the form of institutional reports and water users' databases, and direct observations recorded in field notes and photographs. Although the research design was developed before initiation of the fieldwork, some flexibility was allowed to adapt to unexpected field conditions. This is explained in further detail further in this chapter.

It is important to take into account that the researcher has lived and worked in Argentina (as homeland) and in Ethiopia (intermittently for five years); this undoubtedly contributed to the research approach and positionality. On the one hand, the local work and living experiences were useful in terms of providing knowledge and understanding of governmental structures and policies related to agriculture and natural resource management. Well-established personal networks of relationships and contacts and operational facilities helped to conduct research. On the other hand, it was realised that those background experiences might also be a source of bias influencing the analysis and interpretation of participant responses. Particularly the fact that the researcher had worked in gender issues in the study countries was to be considered to avoid relying on preconceptions and expected responses in regards to gender roles and relations. Therefore, the researcher sought to acquire an in-depth understanding of the current environmental and water resource management conditions, political circumstances and socio-economic particularities of the study areas. This was done through learning from available secondary information, in particular from institutional documents, and discussing with a broad range of different informants. Critical was to avoid the interpretation of results through the lens of past experiences. The researcher was acutely aware of the fact that in both localities relevant changes in socio-cultural configurations in the rural areas have occurred in the last few years.

Figure 3.1 below provides an overview of the research design, locations for fieldwork and sampling strategy to guide the discussion of the study sites selection and methods used that will follow.

Figure 3.1 Research design for the study with locations for fieldwork and sampling strategy



Source: Developed by the author.

3.4.1. Site selection

The two countries selected for this research, Ethiopia and Argentina, have regions that share three common features:

(1) significant presence of smallholders practicing irrigated agriculture as main livelihood activity;
(2) some degree of irrigation water crisis, due to water scarcity, infrastructure deficiency and unpredictability of water availability, and
(3) presence of collective self-governed irrigation schemes, thus water users' associations (WUA).

The Tigray Region was selected in Ethiopia, and Mendoza Province in Argentina. Figure 3.1 provides a summary of the research design and the sampling strategy in each research locality.

3.4.2. Sampling strategy

In quantitative research methods (survey), the sample is selected in such a way that it will represent the larger population of interest. In qualitative research, the sample composition is ‘purposive’ (Morton-Williams, 1985); it does not aim at being representative of the population, but it intends to collect and analyse a broad spectrum of alternative responses to better understand the problem and research questions, as well as the specific contexts where they operate (Creswell, 2013). Table 3.1 presents a summary of the research tools used and sample sizes during fieldwork in both Ethiopia and Argentina.

Table 3.1 Summary of qualitative and quantitative samples in Ethiopia and Argentina

Research tools used in data collection	*Male*	*Female*	*Mixed*
Tigray, Ethiopia (January – February, 2016; March 2018)			
17 semi-structured interviews to key informants	12	5	-
14 relevant open interviews	3	11	-
12 FGD with farmers	4 (n=15)	8 (n=35)	-
1 WUA meeting (observer)	1	-	-
2 pilot surveys	-	2	-
72 surveys of farmers	51	21	-
Mendoza, Argentina (April - December 2016; May-June 2017; April 2019*)			
40 semi-structured interviews to key informants	35	5	-
10 relevant open interviews	9	1	-
6 FGD with farmers	1 (n=5)	4 (n=21)	1 (n=6)
2 FGD with key informants	1 (n=5)	1 (n=4)	-
15 bi-annual WUA assemblies (observer)	-	-	15
3 relevant events (participatory observer)	-	-	3
4 pilot surveys	2	1	1
79 surveys of farmers	42	37	-
3 validation workshops	-	-	3

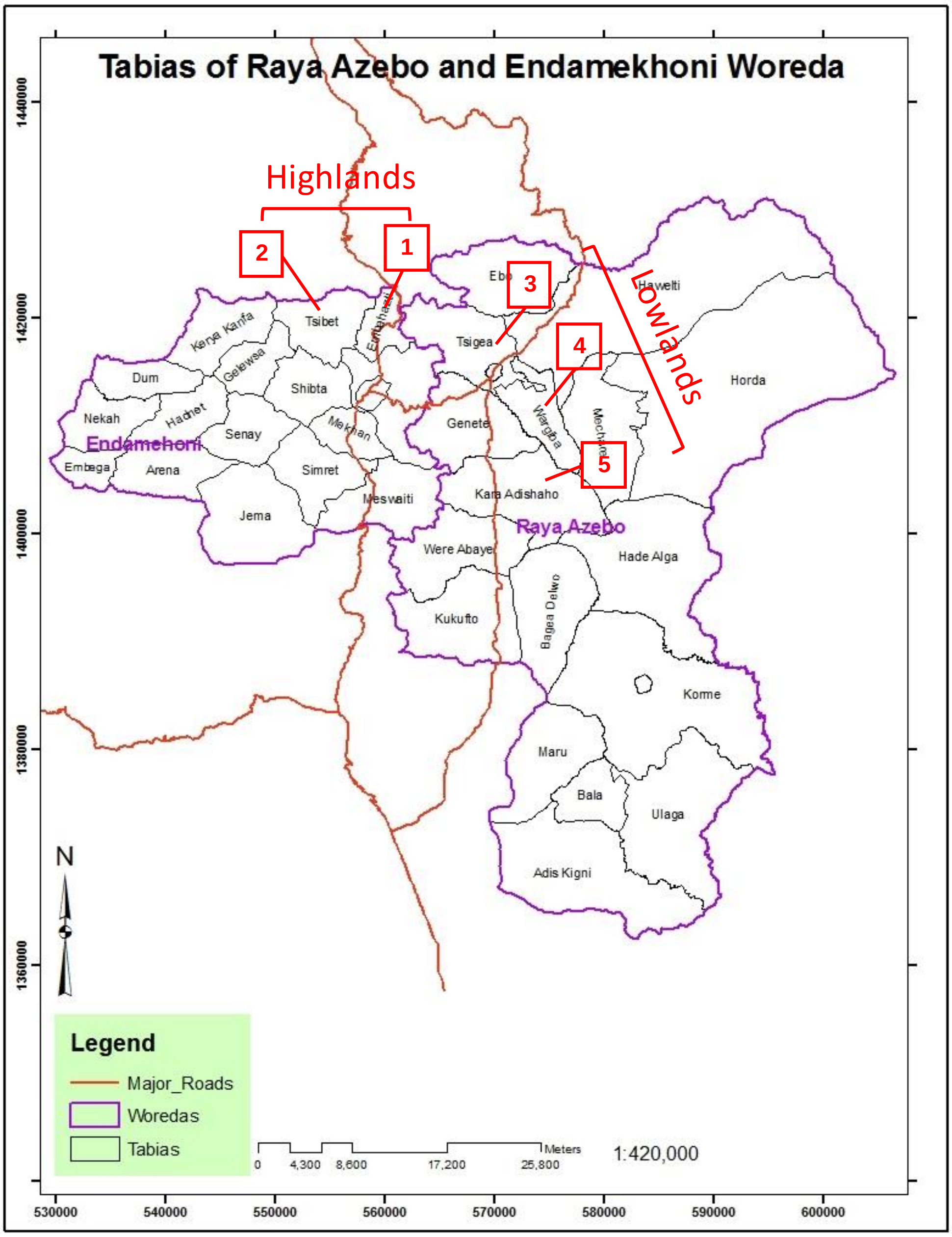
Source: Field data collection for this study. (*): In April 2019, the researcher conducted a single in-depth interview to a woman WUA leader in Mendoza.

Sampling for the study was stratified according to the predominant forms of farming, which in turn are mostly based on the irrigation water source used. This stratification resulted in the differentiation of areas with predominantly use of surface irrigation water, and areas with additional use of groundwater in each of the two study regions. A summary of the research design including sampling strategy was provided in Figure 3.1.

Definition of the research sample in the study sites of Tigray

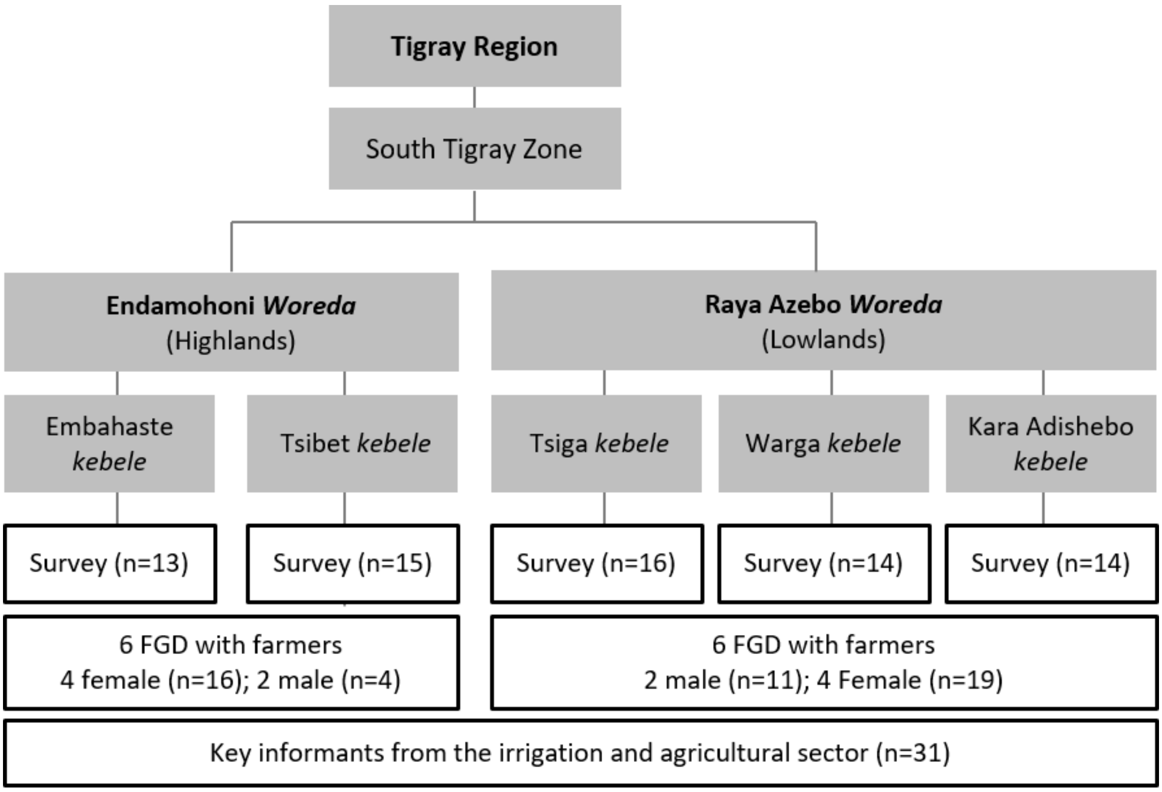
The samples for the study sites in Tigray were composed of farmers organised in WUAs (survey) and relevant key informants (qualitative interviews) of two *kebeles* in Endamohoni *woreda* (highlands): Embahaste and Tsibet, and three *kebeles* in Raya Azebo *woreda* (lowlands): Tsiga, Wargba and Kara Adishebo *kebeles* (Figures 3.2). These *kebeles* were purposively selected in order to have a representation of diverse irrigation systems of the highlands and lowlands. Figure 3.3 describes the qualitative and quantitative sample size defined for each *kebele* in Tigray.

Figure 3.2 Map with study site locations in Tigray, Ethiopia



Source: GIZ Tigray Regional Office (2016) with additions by the author. References: *Kebeles* included in the research: (1) Embahaste; (2) Tsibet; (3) Tsiga; (4) Wargba; (5) Kara Adishebo. (note: *tabia* is the Tigray word for *kebele*).

Figure 3.3 Study locations in Tigray Region, Ethiopia, including size of qualitative and quantitative samples



Source: Developed by the author.

Summaries of male and female population of the study sites as well as accessibility to those areas are presented in Table 3.2.

Table 3.2 *Kebeles* included in each woreda selected for the study, indicating population and accessibility

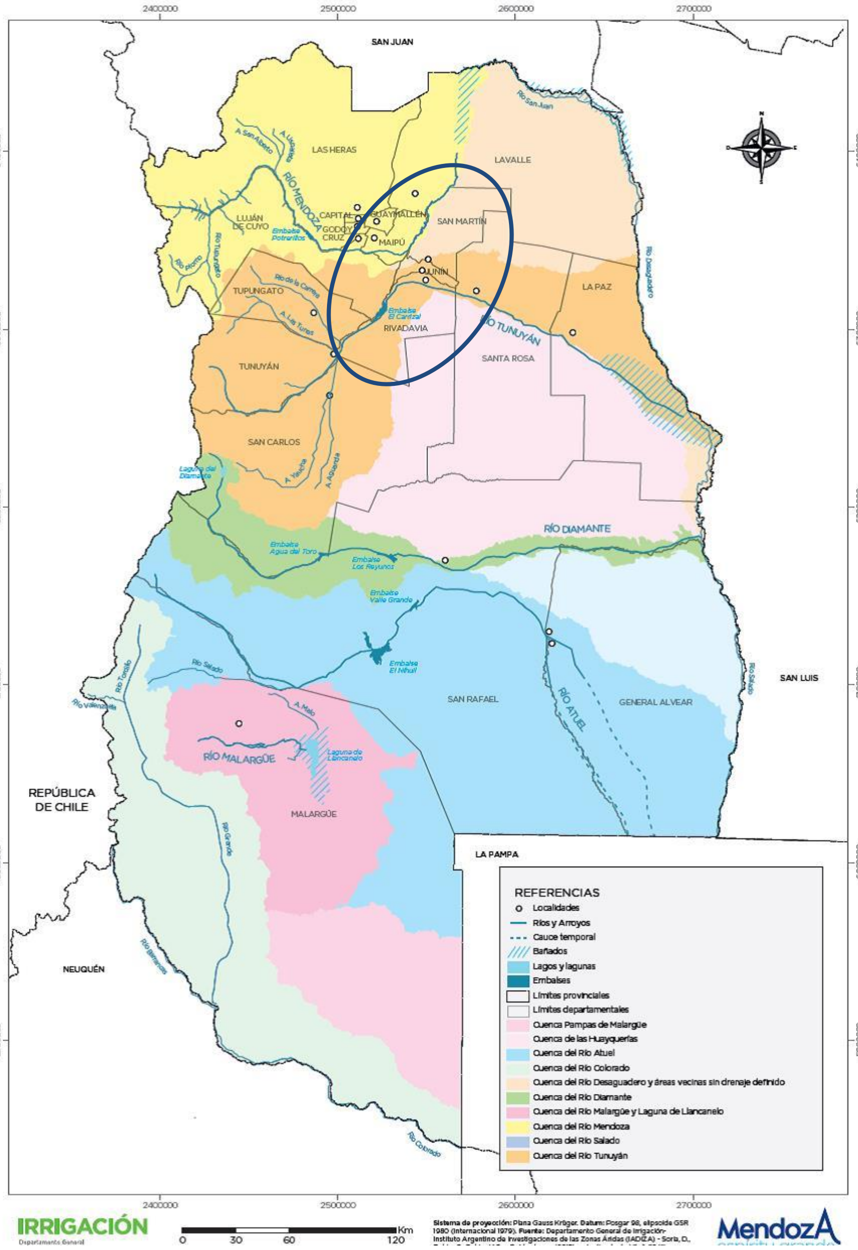
Kebele	**Population**			**Accessibility**
	male	female	**total**	
1) Embahaste*	1,947	2,086	4,033	On asphalt road (Maychew-Mekele); 12 km N of Maychew.
2) Tsibet**	2,247	4,065	6,312	18 km north of Maychew; mountainous, half way asphalt road up to the *kebele* centre, then gravel road.
3) Tsiga***	3,582	3,709	7,291	4 km gravel road up to Mohoni (*woreda* centre).
4) Wargba	3,326	5,116	8,442	Along a main asphalt road, 7 km SE Mohoni.
5) Kara	n.a.	n.a.	n.a.	Along a main asphalt road, 13 km S Mohoni.

Source: Population data provided by *kebele* representatives during field work (January 2016): (*) Embahaste irrigation expert [E_Em-Op-01], Water Office, Maychew [E_May-ID-01]; (**): Tsibet irrigation expert [E_Tb-Op-01], Water Office, Maychew; (***): *Kebele* administrator [E_Tsi-ID-03]. N.a: non-available data.

Definition of the research sample in the study sites of Mendoza

The samples for the study in Mendoza were composed of farmers organised in irrigation water users' associations (WUAs) (survey) and relevant key informants (qualitative interviews) of two river sub-basins in the Northern Mendoza Basin: Lower Tunuyán River and Mendoza River Basins (Figure 3.4).

Figure 3.4 Map of hydrological river basins of Mendoza Province and research locations



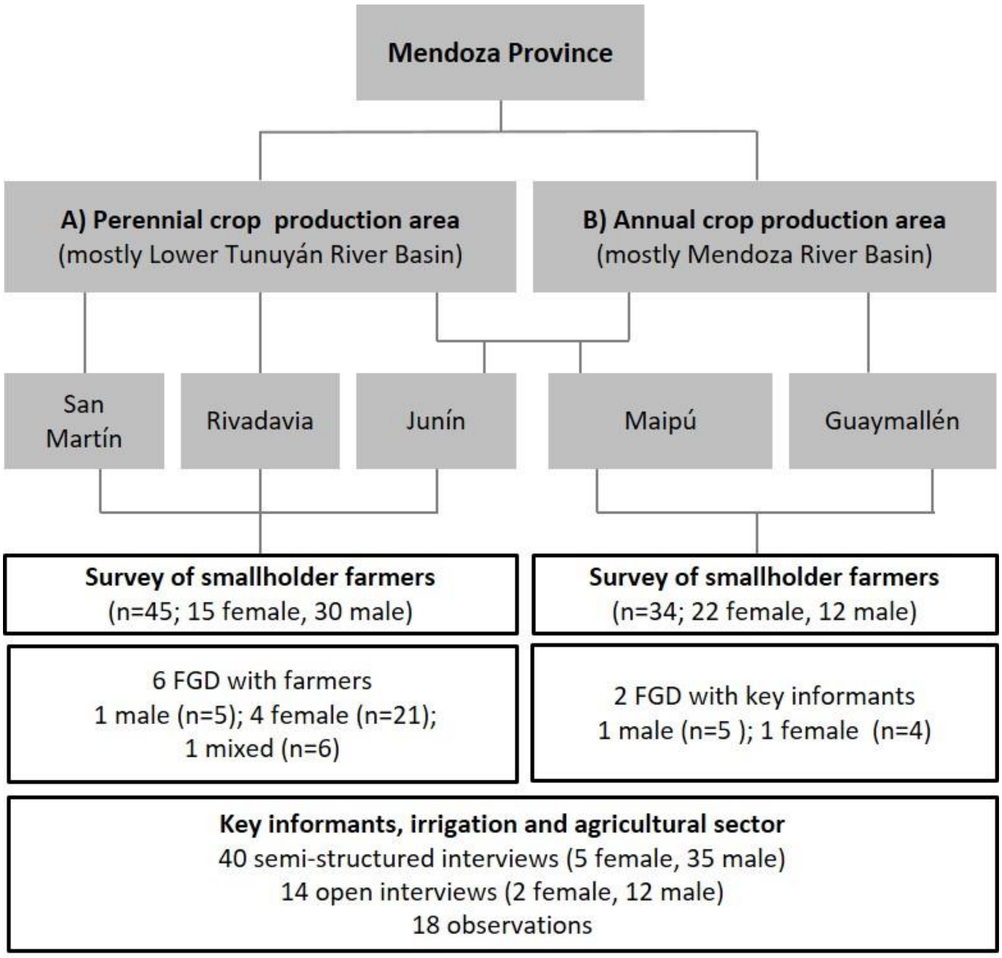
Source: DGI (2016) with addition by the author.

The survey was stratified according to two cropping systems (Figure 3.5):

A. **Perennial horticulture crop production:** wine and temperate fruit[13] production. Surveys were predominantly conducted in the Lower Tunuyán River Basin with farmers producing in three municipalities (San Martin, Junín and Rivadavia). A small number of surveys were conducted in Maipú (Mendoza River Basin).

B. **Annual horticulture crop production:** vegetables for fresh market and for processing. Surveys were predominantly conducted in the Mendoza River Basin with farmers producing in two municipalities (Maipú and Guaymallén). A small number of surveys were conducted in Junín (Lower Tunuyán River Basin).

Figure 3.5 Study locations in Mendoza, including size of qualitative and quantitative samples



Source: Developed by the author.

[13] In this area of the province, the main fruit crops found were olive, peach and plum.

Surveys, group interviews with farmers, and individual and group interviews with WUA leaders were conducted in the service areas of purposely selected WUAs, four from the Mendoza River Basin (WUAs organised in a second grade association called the *Tercera Zona* Association) and five from the Lower Tunuyán River Basin (organised in the *Canal Independencia* Association). Table 3.3 provides a summary of those WUAs showing total hectares of service areas; area and number of private water users of agricultural water with a maximum of one year of water service fees unpaid[14].

Table 3.3 WUAs included in the study from Mendoza and Lower Tunuyán River Basins

River	WUA	Hectares (Ha) service area	Hectares (Ha) of private agricultural water users*	No. of private, agriculture registries	No. of private agricultural water users (no duplicates)**
Mendoza River	Association: *Tercera Zona*				
	- Rufino Ortega	955	805	218	148
	- La Primavera - Pedregal	1,165	486	256	207
	- Hijuela Nueva Sánchez	2,154	994	487	381
	- Canal Vertientes Corralitos Unificada	3,965	1,953	854	694
Lower Tunuyán River	Association: *Canal Independencia*				
	- Cruz Bodega	1,008	890	175	119
	- Henríquez	459	450	83	54
	- Godoy	1,272	909	129	108
	- Canal Matriz Chimbas	4,594	3662	768	477
	- Sauce	2,404	1875	325	123

Source: Data from water distribution list, DGI. Date accessed: 24/10/2016; elaboration of the author. (*) With maximum of one year of water service fees unpaid; (**) Names of landowners having more than one plot registered were counted only once. The table includes the number of landowners without registry duplicates due to farmers having more than one plot registered in their names.

Seven additional surveys were conducted in other WUAs (six in the Lower Tunuyán River Basin and one in the Mendoza River Basin). The characteristics of the irrigation systems, water sources and farming practices of those WUAs are very similar to the nine WUAs primarily researched.

[14] These values may include those farmers that still receive irrigation water but are supported by the governmental climate emergency programme. This Provincial programme supports farmers that had a minimum of 50% of crop losses due to hail, frost or excessive, unusual rainfall (due to El Niño phenomenon). The support consists on delaying the payment of water fees for one year.

Codenames assigned to interviews and surveys

In order to maintain anonymity of respondents, an identification coding system was used that includes a reference letter for the country: 'E' for Ethiopia, and 'A' for Argentina; references for the research site location within country, reference for the type of research tool used and an interview order number. For example, the references for the research location may be:

- Ethiopia: (Em) Embahaste; (Tb) Tsibet; (Tsi) Tsiga; (Wa) Wargba; (Ka) Kara Adishebo.
- Argentina: (M) Mendoza Province (central area); (3aM) Association 'Tercera', Mendoza River; (Ti) Lower Tunuyán River.

The references used for the type of research tool used are: (S) survey; (G) group interview; (ID) semi-structured in-depth interview (individual); (Op) open interview (individual), and (O) observation or participation in an event as observer. For example, for Ethiopia, the first survey conducted in Embahaste *kebele* is indicated as [E_Em_S-01]; for Argentina, the second group interview conducted in the Lower Tunuyán River Basin is indicated as [A_Ti-G-02]. Lists of interviews with codes used are provided in Section 11.1 (Appendices).

Sampling frame

a) In-depth interviews: Purposive, snowball sampling was used for selecting key informants and participants of individual and group interviews. Participants included:

- *General categories for key informants:* Water administration, regional and district levels; agricultural offices, regional and district levels; research and extension offices; universities and technical education related to agriculture and irrigation; government offices dealing with gender issues within the agriculture and water administration sectors; NGOs and cooperation projects; community leaders, in particular belonging to the irrigation governance systems both traditional and non-traditional.
- *Participants in group interviews:* female and male representatives of the WUAs were interviewed. In Mendoza, an additional group interview was conducted to a group of women agronomists working with farmers in the wine sector.

b) Survey: The sampling frames for the surveys were intended to be based on official registries of farmers. However, this was challenging in both countries as explained below.

In Raya Valley, Tigray:

Official registries of farmers organised in WUAs were only partially and often informally recorded by field officers of the *kebele* Agricultural Offices where fieldwork took place. Leaders of WUAs also kept records of their members. Farmer registries consisted usually of loose, handwritten paper sheets. In most cases observed, lists of farmers of the Agricultural Offices did not coincide with the lists of farmers recorded by the WUAs. In some WUAs, the list of farmers was prepared specifically for this research. Field observations indicated that the lists available by the WUAs were more accurate than the ones provided by the Agricultural Offices. In addition, four types of WUAs were found in Tigray, lacking standard registration methods (Table 3.4).

Table 3.4 Types of WUAs types found in Tigray, Ethiopia

Type of water users' organisations	Highlands	Lowlands
Formal WUAs established by *woreda* (district) Agricultural Offices for landless youth. These associations were registered as agricultural cooperatives.	X	X
Formal irrigation WUAs established by the Water Bureau for use of groundwater.		X
Formal irrigation WUAs established by the *woreda* Agricultural Offices for management of water infrastructure, e.g. canal, borehole, water reservoir.	X	
Informal WUAs of diverse size (groups observed having 3 to 5 members) organised for the use of a single water structure, i.e. borehole or water reservoirs of diverse type.	X	

Source: Field data collection for this study in Tigray.

Due to the heterogeneity of the information available, the sampling procedure used for Tigray was as follows:

1. Purposive selection of one highland *woreda* (Endamohoni) and one lowland *woreda* (Raya Azebo). The selection of these *woredas* was made based on interviews to informants from the Regional Water Bureau in Mekele and faculty members of the Faculty of Hydrogeology of Mekele University.
2. Purposive selection of two *kebeles* in the highland *woreda*, Embahaste and Tsibet. The selection criteria used were to select *kebeles* accessible by car (some areas were only accessible by several hours and days by foot); with diversity of water sources, and a good representation of the irrigation systems of the highlands. Detailed information regarding location and characteristics of the WUAs was provided by informants from the Mekele Regional Water Bureau and *woreda* Office of Agriculture in Maychew city (highlands).

3. Purposive selection of three *kebeles* in the lowland *woreda:* Tsiga, Wargba and Kara Adishebo *kebeles*. The selection criteria used were to have a good representation of diverse irrigation systems in the lowlands, and to have representation of the cultural diversity of the region (with the representation of Christian and Muslim groups). Detailed information regarding location and characteristics of the WUAs was provided by informants from the Mekele Regional Water Bureau and *woreda* Office of Agriculture in Mohoni city (lowlands).
4. Lists of existing WUAs from the selected *kebeles* in the highlands and lowlands were gathered from the *kebele* Agricultural Offices. Lists of members of those WUAs were also provided by the *kebele* Agricultural Offices and when possible, leaders of the WUAs also provided farmers' lists. After comparing those lists, the most up-to-date were used.
5. A preliminary random selection of members from those WUAs was conducted with a sampling intensity of 3-5%.

In northern Mendoza:

The sampling frames were intended to be based on official registries of farmers. However, this information was not easily available in Mendoza. Usually, government support agencies only collect data from farmers supported by specific projects. Complete registries of farmers producing in a given area were not available. The most complete database found regarding land used for agriculture was the official database of water right holders from the Provincial Water Office (*Departamento General de Irrigación*, DGI). This database contains data from all surface water rights belonging to the six rivers of the Province. The database consists of several fields including: river, WUA, type of water right[15]; type of use for water[16]; type of landowner[17], and payment status of WUA's fee[18]. Additional fields include name of water

[15] Type of water right can be: definitive, eventual or precarious.

[16] Type of use of water can be: agricultural, industrial, drinking water, energy production.

[17] Landowner can be: private or public entity.

[18] Payment status of WUA's fee can be: ‘Hectare yes’, when there is no bimonthly fee owed, or ‘Hectare No’, when there are fees of at least one bimonthly period pending of payment. Generally, when a landowner appears having ‘hectare no’, water is not delivered. Exception was found in those cases of water rights being used for farming in farms that had been declared in ‘climatic emergency’ due to frost or hail storms when the producer lost a minimum of 50% of the crop production. In these cases, the water right holder is allowed to delay water payment for a maximum of one year. It is important to note that other cases of ‘hectare no’ were found but water still being delivered, in the case of many public entities holding water rights and owing important amounts to WUAs.

right holders, and identification codes for water users, rivers, basins, WUAs, and DGI local office.

For the purpose of this survey sampling, the following sampling procedure was used:

1. Purposive selection of four WUAs in the Mendoza River Basin, with annual crops as predominant cropping system, and five WUAs in the Lower Tunuyán River Basin, with perennial crops as predominant cropping system. The selection of these WUAs was based on recommendations from DGI advisors, WUAs leaders and the director of the district agricultural research and extension agency (INTA Junín), and following the criterion of selecting areas with a high representation of small-scale farming units.
2. The DGI database of water right holders was filtered according to the following fields: river, WUAs, payment status of WUAs' fees ('Hectare yes or no'); type of entity for the land holding; type of water right, and type of use for water. Table 3.5 summarises the selected WUAs after applying relevant filters.

Table 3.5 Selected WUAs of Mendoza for the survey sample

River	WUA	Hectare (Ha) Yes/No	Entity	Water right category	Water use type
Mendoza or Lower Tunuyán	WUAs of Mendoza River: - Rufino Ortega - La Primavera - Nueva Sanchez - Corralitos WUAs of Lower Tunuyán River: - Cruz Bodega - Henríquez - Godoy - Carril Chimbas - Los Sauces	'Ha yes' <u>and</u> 'Ha no' with a maximum of 6 bimonthly unpaid fees	Private	All existing types: - definitive - eventual - precarious - summer irrigation water reinforcement	Agricultural

Source: Author's elaboration based on water distribution list of DGI updated up to July, 2016.

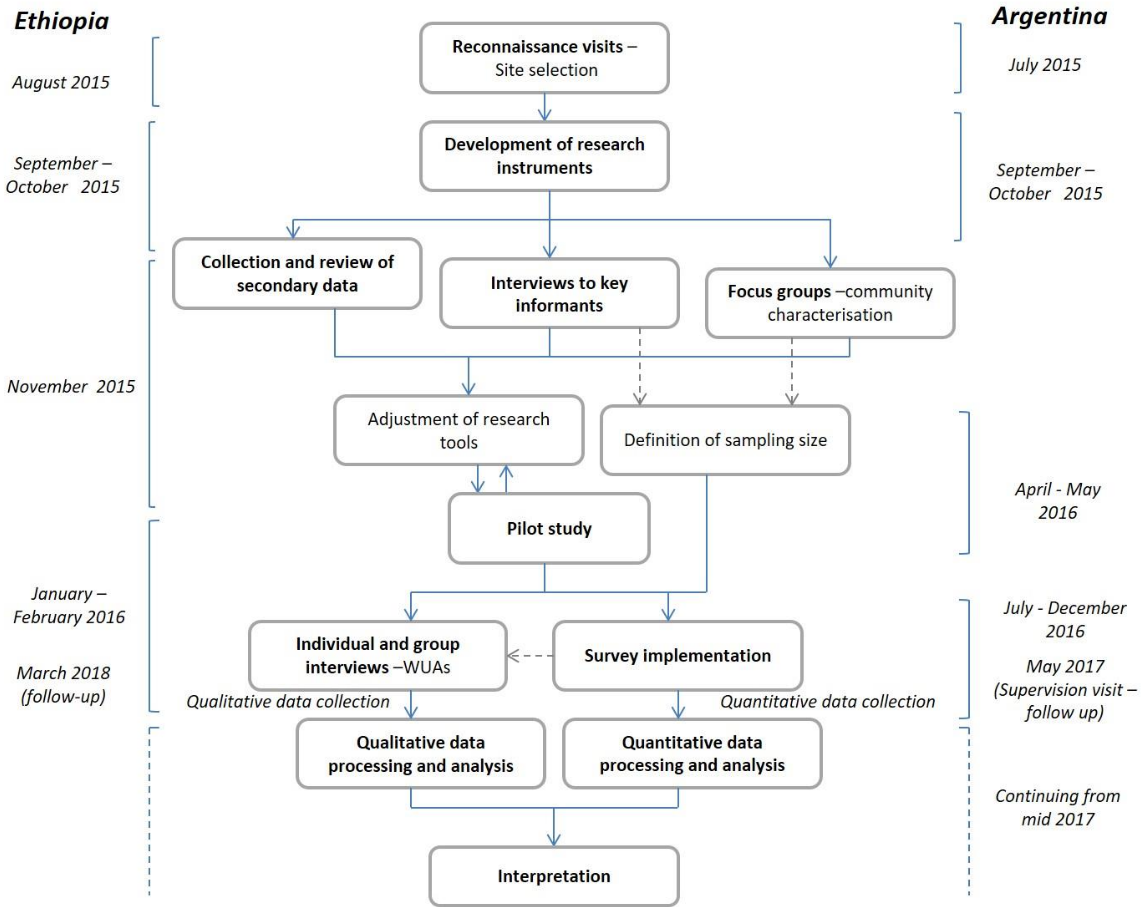
3. All resulting entries, thus all water right holders resulting from applying the mentioned filters, were stratified by land size as follows: 0.5 - 2 ha/ 2 - 4 ha/ 4 - 6 ha/ 6 - 10 ha, and > 10 ha. This land size stratification results from the analysis of water right holders and land stratification as described in Chapter 4, Section 4.4.4.
4. Within each sub-group, a preliminarily and randomly selected proportion of water users were selected with a sampling intensity of 3-5%.

3.4.3. Implementation sequence

The implementation sequence for this research mostly followed the model 'convergent parallel mixed methods' defined by Creswell (2013). The field research was structured into the following phases in each of the research locations (Figure 3.6):

1. **Reconnaissance field visit** and informal discussion with relevant informants
2. **Development of research instruments:** questionnaires and interview guidelines
3. **Interviews to key informants, group interviews, and collection and revision of secondary data**: this phase allowed adjusting the survey questionnaire and collecting specific information required
4. **Adjustment of research tools**
5. **Pilot study** to test research tools (in Ethiopia and in Argentina)
6. **Adjustment of research tools**
7. **Survey implementation** (illustrated in Figure 3.7)
8. **Group interviews** and **individual interviews of WUAs** (Figure 3.7): this phase aimed at expanding information gathered through the surveys with specific focus on the functioning of the WUAs. This phase allowed to cross-validating findings, gain a broader understand regarding what relationships exist between household water use and management, as well as the role, relevance and influence of WUAs.
9. **Validation of findings** occurred throughout the phases in order to identify accuracy in the information gathered (see Section 3.6).
10. **Analysis of results:** during this phase, quantitative and qualitative results were analysed separately and contextualised according to each research site.
11. **Integration of results:** during the interpretation phase results of both qualitative and quantitative phases were interpreted jointly. Likewise, results from Tigray and Mendoza were interpreted concurrently.

Figure 3.6 Research implementation sequence



Source: Developed by the author.

Figure 3.7 Images of field data collection in Ethiopia and Argentina

Source: Fieldwork Tigray (up left, down right) and Mendoza (up right, down left).

3.4.4. Implementation of the survey: procedures and challenges

A significant challenge in both research locations, Tigray and Mendoza, was to actually *find* the selected farmers. In addition, in both countries, individual female and male members of households affiliated to a WUA were intended to be interviewed. The head of household and/or the spouse were surveyed. After several weeks of conducting fieldwork, it turned out that interviewing a balanced number of male and female farmers through a randomised selection of participants was not possible. At most, 20% of the surveys conducted were with women. Therefore, in a second stage of fieldwork (see Figure 3.6 -follow up surveys in each country), it was decided to purposely interview female farmers or wives of farmers.

Raya Valley, Tigray

After defining the random sample of farmers, a field officer of the Office of Agriculture of each *kebele* called the leader of the corresponding WUA and made an appointment with the selected members (farmers), usually in the *kebele* centre or other agreed location. This process was not always straightforward and it usually demanded a second visit per location. For each appointment, the researcher organised a team of two to four enumerators/translators to conduct the individual surveys.

By far the most challenging aspect of the fieldwork in Ethiopia was to organise a team of enumerators/translators with acceptable English skills and commitment. While in general, farmers were willing to participate, assuring the commitment of the enumerators/translators was very challenging. Each survey was planned to last about 30 minutes. If one or more enumerators did not show up for the agreed date, farmers had to wait their turn longer than planned. In a few cases, farmers left the place before the interview when the delay became too long.

Finding skilled enumerators with adequate level of English to conduct the surveys is difficult in this area. The most qualified persons are already employed and they cannot leave their jobs for a short-term job like the offered by this research. The alternative was to find persons with a higher education degree or university students and provide a short training to conduct the survey. This process needed to be repeated a few times, since after one or two days of work, some trained individuals dropped out after the training and did not continue working. Also, finding assistants that worked meticulously was difficult.

It was found that several farmers thought that this survey was directly or indirectly linked to a development programme, despite the researcher's introduction and reading of the consent form. This may in part explain that farmers were in general willing to participate. However, some were found less willing to provide detailed information of their production systems. In general, farmers were found to be not very communicative, which resulted in narratives that were restricted to short answers to the questions of the researcher.

Northern Mendoza

After defining the random sample of farmers, the researcher worked with the person in charge of water distribution in each locality (locally called '*tomero*') to confirm if: a) the agricultural right holders selected in fact were small-scale farmers[19], and b) which of the selected agricultural right holders were currently producing. The database provided by DGI was not fully up-to-date. Consequently, a number of water right holders selected did not meet the selection criteria. Also, not all water users with an agricultural water right were found farming. A number of farms with water rights were found abandoned due to the persistent economic crisis of the agricultural sector[20], or due to land tenure issues. Also, cases were found in which land previously used for farming had been converted into semi-urban real estate investments. This was quite common in the WUAs of the Mendoza River Basin.

For this fieldwork, a driver from DGI with good knowledge of the rural areas was provided, although not always available. This allowed visiting farmers in their homes or in any agreed location when phone numbers were available. However, finding farmers was challenging and time consuming. Leaders from the WUAs do not keep phone contacts of all farmers. For this reason, in each WUA the researcher spent a significant amount of time with the water guard (*tomero*) getting directions to find farmers to be interviewed. Many selected farmers did not live on the farm or were not present at the moment of the visit. This obliged the researcher to visit some farmers more than once.

Conducting a very detailed survey as the one designed was time consuming. Each survey was planned to last 35 to 40 minutes maximum. They usually took between 60 to 90 minutes.

[19] In some cases, a same landowner may have several farms with different registry number exceeding the land size categories considered for small and medium scale producers.

[20] This issue is further explained in Chapter 4.

In contrast to Tigray, respondents in Mendoza were rather willing to talk about their farms, their problems related to the agricultural sector, and in particular, about their concerns regarding the water management system. Many farmers do not have many opportunities to communicate their frustrations about the system, and the interviewer received many of those complaints. Also, drive time from one farm to another took about 20 to 40 minutes. In a 'good' working day it was possible to conduct 5 to 8 interviews with the help of an assistant.

3.4.5. Data recording and transcriptions

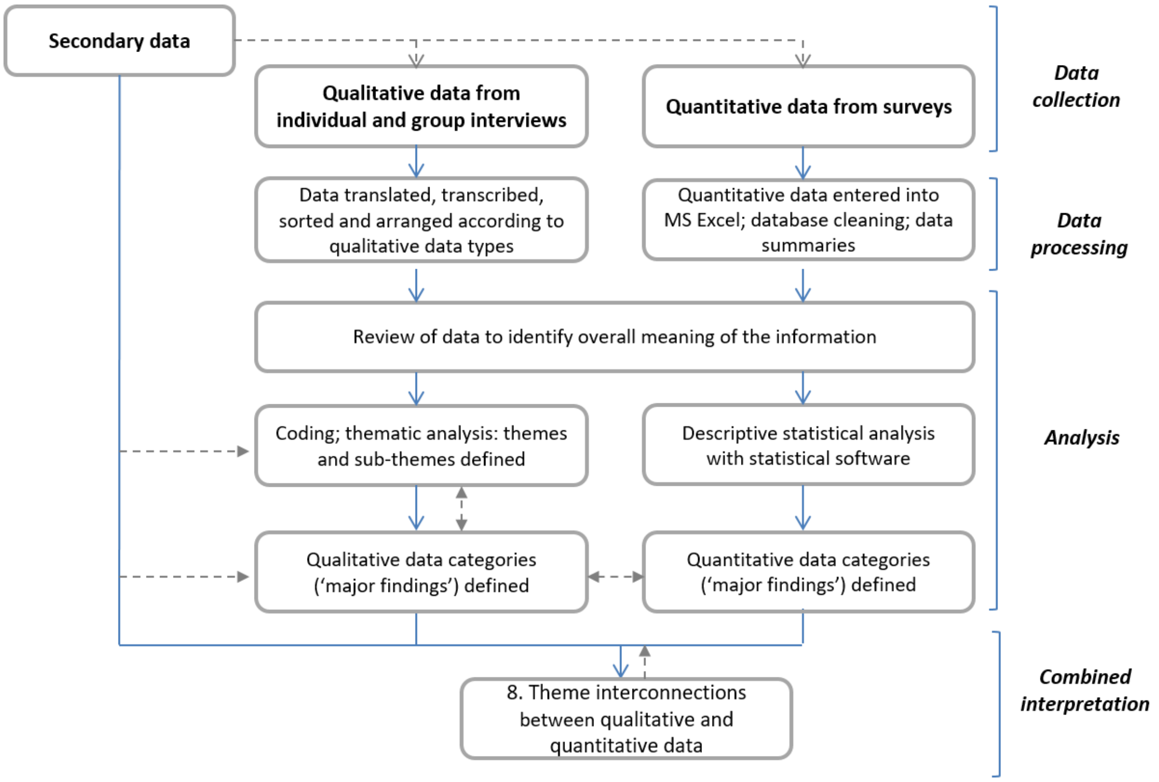
Field data was mostly recorded by notes: on the questionnaire and in the field notebook of the researcher. When appropriate, interviews and FGDs were audio recorded. Other data collected include audio-visual materials, i.e. photographs, tape and video recording. Notes were transcribed and digitalised to a personal computer. Observational notes were gathered in a researcher's journal. Individual and group interviews from Ethiopia and Argentina were transcribed regularly shortly after the field data collection period. In Ethiopia, surveys were completed in *Tigrigna* and later translated into English. Translations were done with the support of two PhD students from Mekele University. In-depth interviews and group discussions were conducted by the researcher in English when possible, or in the local language with translation during the interview. In Argentina, all interviews and surveys were conducted in Spanish. In-depth interviews and group discussions were audio recorded and transcribed. The researcher translated data into English.

Transcriptions of qualitative data were done manually, and typed into MS Word. All digital material was sorted and arranged according to the various data types. While still in the field, completed survey questionnaires were regularly checked to follow up the work of enumerators. At the end of each week of fieldwork in Ethiopia, surveys were reviewed by the researcher and translated into English with the help of a native speaker graduate student.

3.5. Data analysis and interpretation

After data were transcribed, verified and corrected where necessary, data sets were first analysed individually, then combined for comparative analysis. The data analysis steps are summarised in Figure 3.8.

Figure 3.8 Summary of sequence of data processing and analysis using a mixed method approach



Source: Developed by author.

Qualitative data were systematised using QSR NVivo (version 11). The qualitative data analysis software package was used to code and categorise data. Quantitative data from surveys were databased in MS Excel. The data from fieldwork in Argentina were computerised during the fieldwork phase. For a first integrative review of the datasets, a series of quantitative data summaries were produced. Quantitative data were then exported to IBM SPSS (version 24).

The mixed research approach requires careful evaluation of the relationships between qualitative and quantitative data (Bryman, 2012). This was done through (a) the application of methods for qualitative analysis (coding and thematic analysis); (b) application of methods for quantitative analysis (descriptive statistics), and (c) integrative summaries of qualitative and quantitative data.

Coding of qualitative data: Coding is viewed as the key stage of analysing qualitative data (narratives and pieces of text) and requires assigning a word or phrase that synthesises a certain concept (Gibbs, 2002). In other words, narratives and text are transcribed into words or short phrases accurately capturing their concept. The coding process used in this research included the following tasks:

- A code was assigned for each relevant piece of text from the narratives (initial open coding) (Bryman, 2012). This process combined manual coding (margin writing on printed copies of the transcribed interviews) and the use of NVivo: a first close reading of all the material generated codes in paper; those codes were then reviewed in order to combine, re-name or eliminate codes. Through the analysis of the sets of codes obtained, an index of 'nodes' was created in NVivo. Node is the term used by the software to describe the 'object that represents an idea, theory, dimension, characteristic, etc. of the data' (Gibbs, 2002: 243). Accordingly, the codes obtained from reading the interview transcripts and other relevant text material were organised into nodes.
- Each node was described (using the node property feature of the software) with the ideas and reasons the researcher had for its creation. The resulting set of nodes and node properties was read and re-defined as required. Next, a hierarchy of nodes ('node tree') was developed based on combining (a) overarching themes from the research questions and literature review, and (b) sub-themes (codes) emerging from the data (Bryman, 2012). Reviewing sub-themes ('focused coding') was done in an iterative process in order to refine and identify more meaningful themes (Bryman, 2012).
- A number of those codes and themes were quantified, and the frequency of appearance in the qualitative data was counted. These quantifications were later contrasted with results from the quantitative data.

Analysis of variables from quantitative data: The questions from the survey generated a number of different types of variables (intervals, ordinal, nominal and dichotomous) (Bryman, 2012). Those variables were subjected to frequency analyses. Data categories ('major findings') from the quantitative data were developed.

Subsequently, a thematic analysis was conducted. Themes were analysed in relation to 'case attributes', defined as intrinsic characteristics of respondents such as gender; education levels; livelihoods and social status (Gibbs, 2002). This helped to increase the conceptual understanding of the variables analysed, and the themes that had emerged from the analysis. It also allowed to identify relationships between qualitative and quantitative data. For this analysis, a matrix was developed including interviewees in rows and, variables and themes in columns.

Thematic interconnections between qualitative and quantitative data were analysed and synthesised into an analytical scheme. The resulting categories were related to the themes or categories defined in the conceptual framework developed for this research. The results informed adjustments of the conceptual framework.

3.6. Data validation and accuracy of findings

In order to ensure quality (reliability and validity) of the measurements/data (Bryman, 2012), a number of strategies were applied:

- Discussion of research instruments with relevant advisors (i.e. PhD supervisors; IWRM specialist; geographer and gender specialist) and implementation of a pilot study to ensure questions and measurements proposed were in fact related to the research concepts as desired.
- The randomised selection of participants was an element of validity for the surveys.
- Triangulation using various methods and sources of data as well as verification of the researcher's observations with third party observers was performed throughout the data collection. The use of qualitative and quantitative data allowed confirming findings from both types of data (Bryman, 2012).
- The research implementation sequence (section 3.3.4) provided well-validated findings and a broader perspective from different types of data taken at different levels during the study. In order to compare results of all the phases, some qualitative data required quantification, by creating codes and themes (Creswell, 2013). A follow-up piece of fieldwork conducted in each location a few months after the core fieldwork allowed the researcher to fill in gaps and corroborate data.
- Due to the need of using translation to administer the questionnaires in Ethiopia, regular checks of responses and use of third party observers were required.
- A supervision visit in Mendoza helped reflect on findings, and adjust the data collection to ensure that sufficient relevant data were collected.
- Additionally, findings were validated with local peers. In Mendoza, three validation workshops were conducted with high-level staff members, which included managers and technical officers. In Ethiopia, two validation meetings with key informants (Head of Water Supply of the Regional Bureau of Water and Energy of Mekele and Head of the Raya Azebo Woreda Agricultural Office) were conducted (March, 2018).

3.7. Ethical considerations

The following ethical guidelines were observed at all moments of the research process:

1. Completion of the Research Permission and Clearance required by the University Research Ethics Committee.
2. Observance of local rules and customs regarding data collection and fieldwork. Permission to collect data followed the required hierarchical levels. Local stakeholders were informed regarding research objectives, logistics of the research, and use of the data and information collected. This included obtaining a letter of support from the highest local water administration in Tigray (Appendix 14). Such a letter was not required in Mendoza.
3. Used of a consent form to be acknowledged by interviewees during the first contact meeting. This procedure was composed of a brief introduction of the researcher; a description of the research project and the consent form to be shown/read (Appendices 15 and 16).
4. All interviewees were anonymised by assigning codes as described in section 3.4.2.
5. A written brief of the research results was provided to the supporting organisation (DGI) in Mendoza. Due to the change of national and regional authorities in Ethiopia in 2018, the officials who were informed about (and supported) this research were replaced; therefore, a submission of a written brief of the research results to official authorities has been problematic. Nevertheless, the researcher maintains professional contact with researchers from Mekele University with whom paper drafts and publications have been shared.

3.8. Considerations regarding challenges related to the fieldwork

In the research locations of both countries, a number of challenging aspects had to be considered for conducting this comparative, cross-cultural research:

- *Knowledge of the research locations and cultural factors:* having worked in Ethiopia and having visited Tigray for several extended periods of time provided the researcher with useful background knowledge about cultural issues, institutional arrangements as well as some particular local customs, not usually evident from the outside. This was of course not a problem in Argentina, her homeland.

- *Linguistic factors:* the fact that questionnaires needed to be prepared in two languages (Spanish and English), particular care was given to maintain comparability (Bryman, 2012). In Ethiopia, the interviews had to be administered in *Tigrigna* (the most common language spoken in Tigray). For this purpose, a bilingual translator (English/Tigrigna) conducted the interviews while translating to the researcher. It was not possible to use professional translators, but the researcher had the support of qualified graduate students on the fields of agriculture and hydrology.
- *Availability of comparable and reliable data:* both countries have several official statistical databases at national and regional levels. An analysis of categories and indicators was required when using secondary data in order to ensure they were comparable.
- *Diverse administrative structures and political systems:* in order to establish valid comparisons, a careful definition of the unit of analysis (the water users' association) in each country was a key aspect of the study (for a detailed description of water users' associations in each research site, see Chapter 4, Sections 4.3.6 for Tigray, and 4.4.6. for Mendoza).
- *Cost of the study and research funds:* The extent of the implementation of fieldwork in each location was to a degree constrained by research costs and availability of research funding. Due to personal arrangements, the researcher had a number of logistic facilities available in Argentina, which included transport to the field, access to otherwise non-public information such as water right holders' databases, and a stipend for a research assistant. The researcher had also access to some logistics facilities in Ethiopia, however considerably less than the resources available in Argentina. Most of research costs in Ethiopia were self-funded by the researcher.
- *Availability of time:* The comparative study required substantial time and flexibility to travel to these distant locations. The fieldwork phase including reconnaissance visits and data collection in both countries demanded a period of 18 months distributed from July 2015 until March 2018.
- *Risks related to the fieldwork:* An important aspect of caution while conducting fieldwork in Ethiopia was the unstable political climate before the change of government in 2018. However, during the course of the fieldwork, the region of Mekele and Raya Valley (the sites of the study) in Tigray were not affected by demonstrations or unrest. This allowed for a smooth completion of the fieldwork. In the case of Mendoza, sporadic

robberies were a source of risk in some of the rural areas visited. This risk was managed by traveling to those areas always accompanied by a professional driver.

3.9. Considerations regarding the researcher's positionality

Deciding to conduct a comparative analysis in two areas of two very different countries was anticipated to be challenging in various aspects: research design, logistics, working languages, research costs, data processing and integrated analysis. An additional layer of anticipated complexity was to study gender issues within a traditional masculine sector such as the irrigation water management sector. And, deciding to organise and conduct a survey without full support from a local organisation, as well as operating within a limited budget combined into a rather challenging research setting. However, and despite the complex study context, being able to confirm the usefulness of such an approach during the reconnaissance and scoping phases in both countries justified the overall effort.

In Mendoza, homeland of the researcher, creating trust with respondents, in particular with farmers, was smooth. Sharing the cultural background facilitated open conversations. The fact that the researcher was pursuing a higher educational degree through this research work created empathy and farmers' willingness to participate. As a cultural characteristic, informants in Mendoza were in most cases willing to share their points of view and opinions, in particular, regarding issues related to irrigation water and management of WUAs. By contrast, in Tigray, there was a need to first establish trust with the informants, and then providing convincing reasons to motivate them to take part in the interviews. In addition to the researcher being a foreign person, some difficulties to conduct interviews were because in Ethiopia, field studies are frequent and place high time demands on farmers and local institutions. Some key informants may be asked often to take part in studies. This becomes a nuisance. However, having worked in the country for several years helped the researcher to be aware that Ethiopia is a difficult context for obtaining information from local offices when there are no monetary or project outcome incentives. In the case of the interviews at the regional water and agricultural offices, this challenge was overcome by a well-established network of contacts with local university researchers and sector officials, who provided introductory letters and organised introductory meetings. In the case of the fieldwork in the rural areas, establishing trust with farmers was facilitated by having the support of a woman research assistant and translator, who was a young university professor in the nearby city of Maychew. When she introduced herself and the reason for our visit, in most cases interviewees where willing to participate. As explained in Section 3.3.5, conversations were usually restricted to short answers to the questionnaires, also because of the language limitations. Interestingly, the researcher could established rich conversations in particular with women leaders of WUAs and community support groups in social gatherings after the interviews or during the walking times between households or meeting points. Likewise, in some occasions, female farmers invited the researcher for tea and coffee into their homes, providing valuable opportunities to strengthen personal connections and better understand the life experiences, aspirations and challenges of rural women.

A matter of consideration before the fieldwork was how the researcher's role(s) and her position as a woman and from outside of Tigray, would influence the overall fieldwork process. As an educated person in a privileged position, there were no major issues to conduct open and informative conversations with governmental officials. Sharing professional interests and having worked in Ethiopia in the past were useful entry points. Hesitations to provide information were only found when questions referred to certain contested governmental agricultural policies, for example, the obligations imposed on farmers to apply fertilisers (sold exclusively by the government) and other improved farming practices. The researcher had to balance the need to better understand farmers' constraints and to avoid tensions with governmental officials. In the rural areas, the issue of being a woman did not represent a constraint as, being a foreigner -'outsider'- allowed a different position than what it is socially acceptable for local women; there was no demand for following the traditional rules, except showing respect for those rules. Respect for local rules and cultural sensitivity are skills gained along many years of international work. The issue of being an outsider who did not speak the language was managed by relying on a research assistant that was trusted and respected in the communities, and a number of translators. In addition, the researcher had obtained permission letters from the Regional Water Bureau that allowed accessing officials from lower level offices, who in turn, introduced extension staff and leaders of WUAs. Once these contacts were established, it was possible to select farmers from the WUAs' registries and be introduced to the selected survey participants.

In the case of Mendoza, the researcher was perceived as an 'insider' because she had worked as an external advisor for the Central Water Office of Mendoza (DGI). This facilitated the interaction with governmental officials. In the rural areas, the researcher was well-accepted partly as an 'insider' due to her family background in Mendoza, but also as an 'interesting outsider', an educated person not having lived in the country for several years. In some occasions, the researcher was identified as a staff member from DGI. Therefore, it was necessary to explicitly explain that the researcher was not an employee of the organisation.

In both countries, the researcher made clear whenever possible that she was a student, learning from their farming practices and irrigation management in order to better understand their irrigation governance systems. This was helpful and necessary to better deal with the asymmetrical position of the researcher and the informants.

3.10. Chapter summary

This section has presented the research approach, the criteria used for selecting the study sites, and the research methods and data collection tools used. A detailed description of the data collection process in both study locations, Tigray and Mendoza, was discussed. This included specific details of the challenges faced during data collection in both countries, as well as the strategies to overcome those difficulties. Also, this section has described the sequences and tasks performed during the analysis and interpretation of results. Finally, the chapter discussed considerations regarding data validation, research ethics, and the researchers' position.

4. Context

4.1. Introduction

The objectives of this research study (in Chapter 1) and the layout as a transregional multi-case mixed-method research approach (in Chapter 3) required research conditions as diverse as possible. To allow for diversity in the study of SSIS governance, a well-developed irrigation context in a mid-income country, Argentina, and a less developed irrigation context in a low-income country, Ethiopia, were selected. These two countries are characterised by widely diverging human development and gender equality backgrounds; elements of which are presented below in section 4.2. The remainder of this chapter presents the context in which the research study was conducted. By applying the conceptual framework developed for the study (in Chapter 2), this chapter also describes the resource systems, actors and water governance systems through a physical, demographic and livelihood characterisation of the research sites and study informants within each case study country; that is, Tigray, in Ethiopia (section 4.3), and Mendoza, in Argentina (section 4.4). These characterisations, as well as the linkages to the external (political, legal and environmental) context of the irrigation systems, are based on secondary data from government reports, literature review, as well as on primary data and findings from the fieldwork conducted between 2016 and 2018 in both countries.

4.2. Human development and gender equality in Ethiopia and Argentina

Ethiopia is a low income, federal democratic republic, with a projected population of 104.9 million in 2017, of which 82.7 million (78.8%) are rural (FAOSTAT, 2017). The gross national income per capita (GNI) [21] for Ethiopia in 2011 was 1,719 USD (UNDP, 2018), with the agricultural value added representing 42% of the gross domestic product of the country (GDP) (FAOSTAT, 2017). By comparison, Argentina is a middle income, federal democratic republic with a projected population of 44.3 million in 2017, of which 3.4 million (7.7%)

---

21 Gross national income (GNI) per capita is calculated by the UNDP report as the ‘aggregate income of an economy generated by its production and its ownership of factors of production, less the incomes paid for the use of factors of production owned by the rest of the world, converted to international dollars using PPP rates, divided by mid-year population’ (UNDP, 2018).

are rural. In 2011, Argentina had a GNI value of 18,461 USD (UNDP, 2018). The agricultural value added in 2014 was 8% of the GDP (FAOSTAT, 2017).

These countries present contrasting situations when characterised by standard human development indicators. According to the Human Development Index (HDI) elaborated by UNDP (2018), Ethiopia exhibits one of the lowest levels of human development in the world. The HDI calculated for Ethiopia in 2018 was 0.463[22] (Table 4.1). Although since 2000, there has been an upward trend in this value, the 2017 HDI positions Ethiopia at 173 out of 189 countries and territories. By contrast, Argentina is considered as a country with very high human development. The HDI calculated for Argentina was 0.825 in 2017, positioning the country at 47 in the HDI rank (see Table 4.1).

Table 4.1 Comparative human development indicators of Ethiopia and Argentina

Country	HDI 2017	HDI Country rank	GDI	GII	Life expectancy at birth		Total Fertility rate (birth per woman) 2015/2020	Maternal mortality (deaths per 100,000 live births, 2015)
					Female	Male		
Ethiopia	0.463	173	0.846	0.502 (Rank 121)	67.8	64	4.0	353
Argentina	0.825	47	0.997	0.358 (Rank 81)	80.4	73	2.3	52

Source: UNDP (2018). HDI: Human Development Index; GDI: Gender Development Index; GII: Gender Inequality Index.

Gender equality remains a critical issue in Ethiopia, which is marked by a very high gender bias as indicated by the Gender Development Index (GDI), with a value of 0.846 (low gender equality).[23] In the case of Argentina, the GDI has a value of 0.997, indicating high gender equality. The UNDP Gender Inequality Index (GII)[24] in 2017, ranks Ethiopia at 121 out of

22 The cutoff points are HDI less than 0.550 for low human development, 0.550-0.699 for medium human development, 0.700-0.799 for high human development, and 0.800 for very high human development (UNDP, 2018).

23 The GDI shows the female Human Development Index (HDI) as a percentage of the male HDI; a high number indicates a significant gender gap within the respective HDI-score. Countries are grouped into five clusters based on the absolute deviation from gender parity in HDI values. The GDI shows how much women are lagging behind their male counterparts and how much women need to improve their status within each dimension of human development.

24 The GII is built on the same framework as the HDI and exposes differences in the distribution of achievements between women and men, taking into account different dimensions; including, health, empowerment and the labour market.

189 countries with a score of 0.502, while Argentina is ranked at position 81 with a score of 0.358 (UNDP, 2018).

Gender gaps in literacy remain important in Ethiopia. Overall, 39% of the population aged 15 and above are literate, and within this number, 47% of women and 63% of men aged 15-24 are literate (UNDP, 2018). In Argentina, in contrast, 98.1% of women and men are literate (UNDP, 2018). Also, in Ethiopia 15.8% of the population has at least some secondary education, while in Argentina this value is at 64.8% (UNDP, 2018).

A usual indicator for gender equality refers to the number of seats in parliament occupied by women and men. In this regard, both countries have a similar rate of participation of women: Ethiopia at 37.3%, and Argentina, 38.9%. A law of gender parity in parliament has recently been approved in Ethiopia, effective from 2018 (Allo, 2018) and in Argentina, effective from 2019 (Straschnoy, 2017).

Concerning the gender equality framework for the agricultural and natural resource management (NRM) sectors, Ethiopia has established ‘gender mainstreaming’ as the backbone gender approach within all government plans and programmes of development. The country has a set of gender equality and mainstreaming guidelines in place that were updated in 2017 (MoANR, 2017). Even though these guidelines provide an advanced policy framework, and the institutional mechanisms to implement those guidelines (see Box 1 below), implementation remains problematic; in particular, at regional and local levels, human resources and budgetary constraints remain the most limiting factors. In addition, as these guidelines are not always backed by governmental proclamations, their enforcement is generally weak - becoming a main cause of the slow progress observed in rural areas.[25]

[25] This observation is based on various gender analyses conducted by the researcher in Ethiopia, for GIZ, between 2014 and 2018.

Box 1: Institutions directly related to women's affairs and gender issues in the agricultural sector of Ethiopia and their mandates (MoANR, 2011; 2017; key informants)

- **National level**
  - *Women's Affairs Office (WAO) of the Prime Minister's Office*
    - Coordination and monitoring of Women's Affairs activities at national level
    - Ensure policy implementation
    - Forum for government and non-governmental organisations at national level
    - Implementation of studies on women issues,
    - Devise strategies to address women's problems
  - *Women's Affairs Directorates in strategic ministries, including the Ministry of Agriculture*
    - Address women's issues at the sector level
    - Report to respective ministry and WAO
    - 'Mainstream' gender issues across the Ministry
- **Regional level**
  - *Bureau of Women, Youth and Children (BWYC)*
    - Regional coordination of women's issues and gender activities, and implementation of the gender mainstreaming national policy
    - Chair coordinating meetings with other Bureaus
    - Conduct extensive gender awareness initiatives related to gender equality and women's rights, e.g., seminars, campaigns, mass media presence
    - Assistance to organised women in associations and cooperatives
    - Secure funds to assist rural landless and urban poor women
    - Conduct surveys and other studies related to women's problems
    - Establishment of regional women federations
    - Major channel to humanitarian support from UNICEF and other donors working on issues related to women, health, and economic empowerment
- **Local levels**
  - *Woreda:* replication of the regional level structure (does not occur in all cases)
  - *Kebele:* few kebeles are assigned a gender focal person.

In the case of Argentina, gender equality awareness and practice have experienced important cultural and socio-economic advances in the last decades. However, the country does not have an overarching gender equality policy framework for agriculture and NRM. Moreover, attempts to establish a general policy framework for gender equality are very recent. In 2018, the Ministry of Health and Social Development launched the first general framework for gender equality ('National Plan for Rights and Equal Opportunities'), which consists of a two-year plan (2018-2020); mainly aiming at creating awareness around the need to close gender gaps. Additionally, particular emphasis is given to employment, and access to health and education for women (INAM, 2018). The document mentions very briefly the importance of considering rural women within the Plan. In addition, there are sectoral and regional programmes that consider issues pertaining to rural women, however, these are mostly oriented to small-scale family farming (IDR, 2019b). They are also scattered and mostly linked to political agendas. The irrigation water sector of Mendoza remains an overwhelmingly male domain. Anecdotal evidence indicates that the number of women holding technical positions was growing (Saurina et al., 2015), although this process seems to be very slow in regards to WUA leadership positions. The water agency has only very recently started to consider women's issues in water resource management. This is demonstrated through a number of actions such as the inclusion of a theme related to women in water management research in their annual water conference (DGI, 2019).

4.3. The study location Tigray, Ethiopia

The Tigray Regional State is one of the poorest regions in Ethiopia, with an agricultural-dependent economy. The total projected population in 2014 was 4,960,003 (50.7% female; 49.3% male), of which 76% live in rural areas (CSA, 2013). Illiteracy reaches 85% of the population (47.3% female and 37.9 male)[26] (CSA, 2012). In Ethiopia, 98% of rural households and 64% of small town households practice farming and/or livestock rearing (CSA & World Bank, 2017). The total area of Tigray is 53,386 km^2, with cultivable land estimated at 1.5 million hectares, of which about 70% is cultivated (WWDSE&CECE, 2014a).

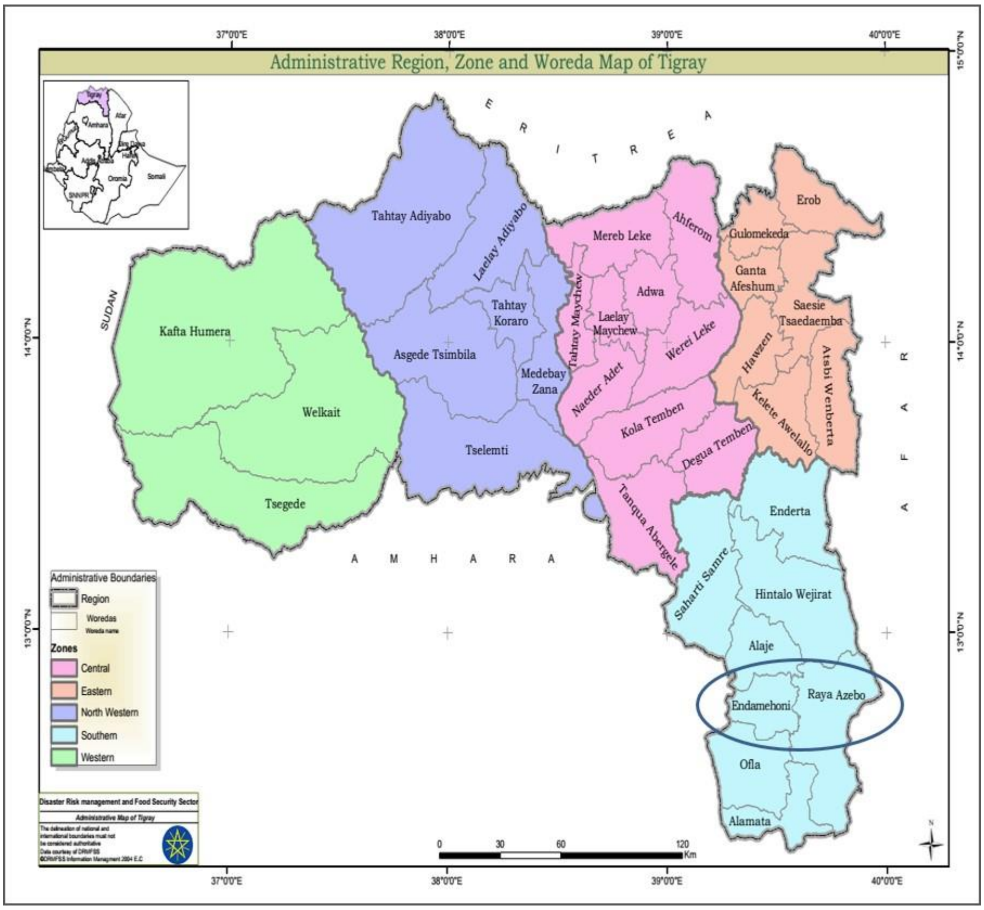
The Tigray Region is formed by five zones[27]: North West, Central, Western, East and Southern Tigray (see Figure 4.1 below). The research sites for this study are located in the Southern Tigray Zone, in two *woredas* of Raya Valley: one *woreda* in the highlands, Endamohoni, and the other in the lowlands, Raya Azebo.

---

[26] Percentages correspond to populations aged six and over (CSA, 2012).

[27] The political division of Ethiopia includes regions, zones, *woredas* (districts), *kebeles* or *tabias* (sub-districts) and *kushets* (villages). *Tabia* is the corresponding *tigrigna* word for *kebele*, the Amharic word.

Figure 4.1 Location map of the study area in Tigray, Ethiopia



Sources: DRMFSS Information Management, 2004, Country Livelihoods profiles, 2007. Circle in the map indicates the study sites in Tigray. Addition by the author.

In the research locations of the highlands, in Endamohoni *woreda*[28], data was collected from two study sites:

- ***Embahaste kebele:*** The *kebele* is composed of four *kushets* or villages: Duqua, Bolenta, Adistgaba and Kolla. This *kebele* has almost 840 irrigate hectares[29]. The survey and in-depth interviews were conducted in Duqua *kushet.*

[28] The Woreda Water Office in Maychew assigns one irrigation expert per *kebele*. The irrigation officers from Embahaste and Tsibet accompanied the researcher to the data collection sites and were of significant help in reaching farmers and having them participate in the study. Both women are originally from these areas and they are well known and trusted within the farming community.

[29] Interview with the Embahaste irrigation expert, Water Office, Maychew (female) [E_Em-Op-01] 02/02/2016.

- ***Tsibet kebele**:* The *kebele* is composed of four *kushets* or villages: Belago, Shamat, Gerhaile and Lalaisebet. The *kebele* has almost 464 irrigate hectares[30]. The survey and in-depth interviews were conducted in Belago *kushet.*

In the research locations in the lowlands, Raya Azebo *woreda*, data were collected from three study sites:

- ***Tsiga kebele:*** The *kebele* is composed of 4 kushets. The *kebele* had in 2016, 254 hectares of rainfed and 40 hectares of irrigated agriculture, with 1,942 farming households[31].
- ***Wargba kebele:*** The *kebele* had in 2016, 1,116 hectares of rainfed and 162 hectares of irrigated agricultural land, with 438 registered farmers: 166 male headed households, 141 female headed households, and 131 youth[32].
- ***Kara Adishebo kebele:*** The *kebele* had in 2016, 225 hectares of irrigated agricultural land, and a population[33] of 3,280 people, 188 female-headed households and 450 male-headed households.

4.3.1. Physical and climatic characterisation of Raya Valley

The topography of the Southern Zone of Tigray Region is dominated by mountains, lower plains and small plateaus. Raya Valley is formed by two sub-basins (see Figure 4.2): The Alamata and the Mohoni sub-basins, which are surrounded by various volcanic mountain systems (Hagos, 2010). The lower plains reach altitudes of between 1,500 to 2,000 metres above sea level (masl), while the mountainous areas are situated between 1,600 to 3,900 masl (MoWR, 2014). The lower plains are intensively cultivated (Figure 4.3).

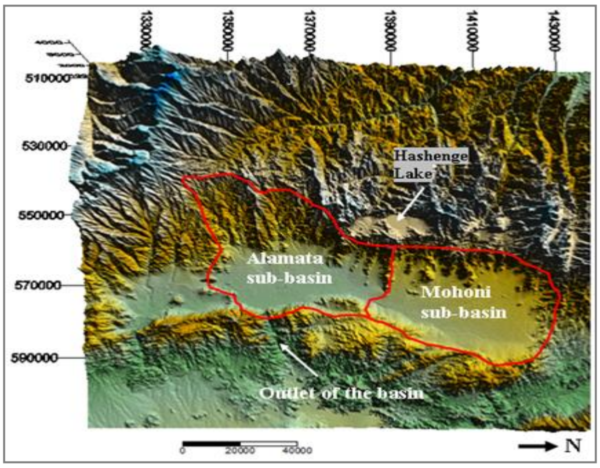
[30] Interview with the Tsibet irrigation expert, Water Office, Maychew (female) [E_Tb-Op-01] 04/02/2016.

[31] Interview with *kelebe* administrator (male) [E_Tsi-ID-03] 30/01/2016.

[32] Interview with *kebele* agricultural officer (male) [E_Wa-ID-02] 27/01/2016.

[33] Interview with Head of the Agricultural Office, Kara Adishebo *kebele*, (male) [E_Ka-ID-01] 16/03/2018.

Figure 4.2 Topography of Raya Valley



Source: Hagos (2010).

Endamohoni *woreda* is a mountainous area with valleys and ridges that range between 1,600 to 3,250 masl and is mostly located in the *dega* agro-ecological zone (see Table 4.2). Raya Azebo *woreda* is located in the *kolla and woyna-dega* agro-ecological zones, with a landscape dominated by plains and undulations mostly between 900 to 2,300 masl (Table 4.2). The main soil types of Endamohoni are fertile Vertisols with some Cambiasols; however, less than 50% of the land is cultivated (ICTA, 2015), as the rest of the area is moderately to very steep (see Table 4.3). Soils in Raya Azebo are mainly composed of unconsolidated material, gravel and coarse sand, developed from recent alluvial and colluvial sediments from the surrounding mountain ranges. They are composed of loamy and silt loam to clay loam in texture, which are deep to very deep, and moderately drained to well drained (Yazew et al., 2010). The topography of Raya Azebo *woreda* presents flat plains and low to moderate steep areas (Table 4.3), which results in moderately to highly suitable soils for agriculture.

Table 4.2 Elevation classes of Endamohoni and Raya Azebo *Woredas*

Elevation classes	Endamohoni Woreda		Raya-Azebo Woreda	
	Area ha	**%**	**Area ha**	**%**
914-1500 (Kolla)	0	-	45,138.11	25.64
1500-2300 (Woyna-Dega)	11,621.91	18.5	128,559.01	73.03
2300-3200 (Dega)	46,342.97	73.78	2,346.09	1.33
3200-3909 (Wurch)	4,843.52	7.71	0	0
Total	**62,808.40**	**100**	**176,043.21**	**100**

Source: GIZ Tigray Regional Office, personal communication (2016).

Table 4.3 Topographic characteristics of the Southern Zone of Tigray, Endamohoni and Raya Azebo *woredas*

Slope classification (range)	Endamohoni *Woreda*		Raya-Azebo *Woreda*	
	Area ha	**%**	**Area ha**	**%**
Flat to gently sloping (0 to 8)	3,181.52	5.07	64,192.97	36.46
Sloping (8 to 15)	6,610.73	10.53	47,990.29	27.26
Moderately steep (15 to 30)	16,658.91	26.52	36,880.32	20.95
Steep (30 to 50)	18,973	30.21	18,351.02	10.42
Very steep (>50)	17,383.13	27.68	86,28.61	4.9
Total	**62,807.28**	**100**	**176,043.21**	**100**

Source: GIZ Tigray Regional Office, personal communication (2016).

Below, figures 4.3 and 4.4 show the typical landscapes of the highlands and lowlands of Tigray Region.

Figure 4.3 Typical hilly landscape of the highlands of Southern Tigray

Source: Fieldwork, Embahaste *kebele*, Endamohoni *woreda*, Ethiopia**.** February 2016.

Figure 4.4 Typical landscape of the lowlands of Southern Tigray.

Source: Fieldwork, Wargba *kebele*, Raya Azebo *woreda*, Ethiopia. February 2016.

The climate of Raya Valley is classified as semi-arid, with a bimodal rainfall pattern ranging from 486 mm to 693 mm per year (WWDSE, 2015). These patterns are relatively erratic and unpredictable. There is a short rainy season called *Belg* during February and March, and a long rainy season called *Kiremt* that extends from June to September - with the highest point in August. Additionally, scattered rains occur at any time along the year (WWDSE, 2015). The climatic parameters vary according to the altitude (see Table 4.4).

Table 4.4 Climatic parameters of Tigray according to altitude

Zone (% of territory)	Altitude (masl)	Average annual temperature (°C)	Rainfall (mm)
Highlands (17.5%)	>2300	12.5 – 16	700-1000
Midland (67.6%)	1500-2300	16 – 25	400-900
Lowlands (14.9%)	<1500	25	650-750

Sources: MoWR (2014); Hagos (2010)

4.3.2. Demography and social characterisation within the research sample

Using data and results from the surveys, interviews to key informants and secondary information, this section provides a demographic and socio-economic characterisation of the rural localities where the fieldwork was conducted.

The population of Tigray is predominantly rural, with small-scale farmers dominating the agricultural sector. The projected population of the two study *woredas* for 2014 was 245,277 inhabitants, with the large majority living in rural areas (see Table 4.5 below) (CSA, 2013). The predominant ethno-linguistic group of Tigray is the Tigrayan population; a large majority of them (96.4%) are defined as Christian Orthodox. The rest are 3.3% Muslims, 0.1% Catholics and 0.1% Protestants (CSA & World Bank, 2017).

Table 4.5 Projected population of Raya Valley by rural condition and gender

Study localities	Total population	Population		Population	
		Urban (%)	Rural (%)	Male (%)	Female (%)
Highlands (Endamohoni Woreda)	92,738	4,230 (4.5)	88,508 (95.5)	45,626 (49.2)	47,112 (50.8)
Lowlands (Raya Azebo Woreda)	152,539	22,831 (15)	129,708 (85)	75,719 (49.6)	76,820 (50.4)

Source: Projected population 2014-2017 (CSA, 2013).

Households in rural areas of Ethiopia are predominantly male headed; an average of 76.8% of men and 23.2% of women are indicated to be heads of household (CSA and ICF International Calverton, 2011). Within the Tigray population aged 10 and above, 47.3% have never been married, 38.6% are in monogamous marriages, 0.2% are in polygamous marriages, 5.8% are divorced, 1.7% are separated and 6.4% are widowed (CSA & World Bank, 2017).

The survey respondents from Tigray were small-scale irrigation landowners of Tigrayan origin. Of the 72 participants in the survey, 70.8% (n=51) are men and 29.2% (n=21) are women (see Table 4.6 below). Additionally, 93.1% indicated that they were heads of household, with 5.5 % as spouses of the head of household. There was also one woman who was the daughter of a head of household, and another person who did not specify household type. While, the majority of male respondents were married, almost all women surveyed were single, widowed or divorced. The average household size estimated for Tigray was 4.6 (CSA & World Bank, 2017); similarly, results from the survey for this study showed the average number of people per household to be 4.77. This value was very similar for both the highlands and lowlands. Additionally, female-headed households appeared to be smaller (see Table 4.7). This would suggest a reduced family labour force in women led households, with effects on their abilities to expand their cultivated areas.

Table 4.6 Characterisation of survey respondents by gender – Tigray

Characterisation of respondents	Male	Female
Average age total (n)	40.5 (50)	39.5 (21)
No answer	2 (1)	0 (0)
% Marital status (n)		
Married	96.1 (49)	19 (4)
Single	2 (1)	19 (4)
Widowed	0 (0)	23.8 (5)
Divorced	0 (0)	38.1 (8)
No answer	2 (1)	0 (0)
% Household type (n)		
Male headed household	98 (50)	19 (4)
Female headed household	0 (0)	81 (17)
No answer	2 (1)	0 (0)
% Education level (n)		
No education	33.3 (17)	81.0 (17)
Primary incomplete	41.2 (21)	14.3 (3)
Primary complete	11.8 (6)	4.8 (1)
Secondary	5.9 (3)	0 (0)
Technical/Vocational	2.0 (1)	0 (0)
No answer	5.9 (3)	0 (0)
% Total respondents (n)	**100 (51)**	**100 (21)**

Source: Survey of farmers; January and February 2016, March 2018.

Table 4.7 Size of respondents' households by research location and gender of head of household

	Average HH size total (n)	Average HH size of male headed HH (n)	Average HH size of female headed HH (n)
Total respondents	**4.77 (71)**	**5.07 (54)**	**3.82 (17)**
Highlands	4.78 (28)	5.28 (21)	3.3 (7)
Lowlands	4.77 (43)	4.94 (33)	4.2 (10)
no answer (n)	(1)		

Source: Survey of farmers; January and February 2016, March 2018. Note: HH=household.

Literacy rates in Tigray are the second highest in the country at 71.3% for men and 51.9% for women. This is after the capital, Addis Ababa, where 96.7% of men and 87.1% of women are literate (CSA & World Bank, 2017). These values include urban and rural areas. For the whole region of Tigray in 2011, almost 10% more women than men had no education (i.e., 47.3% of women compared to 37.9% of men). Similarly, 42.4% of women and 50.5% of men had some primary education (CSA and ICF International Calverton, 2011).

Findings from the survey showed a gender gap in education levels. The results in Table 4.6 above, indicate that female respondents of the survey had in general, lower education levels than male respondents. All together, very few respondents had accessed secondary education, and of those who had, all were men. Also, only one respondent in the lowlands had technical and/or vocational education. Lower education levels for women in rural areas is recognised as problematic for their active participation in irrigation management, training attendance and their adoption of irrigation technology (Meinzen-Dick and Zwarteveen, 1998; Ongsakul et al., 2012; Theis et al., 2018).

4.3.3. Livelihood characterisation of the research sites: Endamohoni and Raya Azebo

Agriculture is the most important activity of Tigray, which is the same case in all of Ethiopia, with more than 86% of households practising some form of farming and more than 80% having some form of livestock production (CSA & World Bank, 2017). This dependence on agriculture is also typical in Raya Valley. Other occupations include casual work as rural labour, petty traders and getting involved in cash for work programmes implemented by the government or development organisations (HEA, 2007a).

Among the surveyed participants, farming was the dominant occupation. Data in Table 4.8, below, suggest that both women and men depend almost exclusively on farming for their survival. All respondents indicated that they were farmers, except for one woman who was exclusively a housewife. Other occupations mentioned (in considerably less frequency) were casual rural labour and/or permanent labour for men, and being a housewife and/or involved in daily labour for women.

Table 4.8 Occupation of respondents in the study sites - Tigray

Occupation	Percentage male (n)	Percentage female (n)
Farmer only	90.2 (46)	66.7 (14)
Farmer + agricultural daily labour	3.9 (2)	9.5 (2)
Farmer + permanent agricultural labour	2 (1)	0 (0)
Farmer, agric. daily labour and migrant	2 (1)	0 (0)
Farmer + non-agricultural employment	2 (1)	0 (0)
Farmer + housewife	0 (0)	23.8 (5)
% Total respondents (n)	**100 (51)**	**100 (21)**

Source: Survey of farmers; January and February 2016, March 2018.

Job opportunities in rural areas are mostly limited to farm labour. The growing presence of agricultural investors in the modernised irrigation areas of the lowlands have increased opportunities for rural labour employment. Anecdotal information during the fieldwork indicated that many of those job opportunities were being filled by male labourers, from other regions of the country. Local farmers showed a preference to work in their own irrigated farms, as making a profit of their own was seen to be much better than what they could earn as a labourer.[34] Female labour demand - preferred for certain activities such as weeding - was met by local rural women.

A gender gap in daily wages was observed. This is an indication that gender inequalities remain engrained in the local society. For example, in Wargba and Kara Adishebo *kebeles*, men earned 100 birr (£2.60)[35] for transplanting vegetable crop seedlings and a range of 70 to 130 birr for weeding. In contrast, women were paid a range of 50 to 80 birr for weeding and transplanting. When asked the reasons for these differences in payment, farmers said that women were slower than men in transplanting work, and faster than them in weeding; therefore, men were not usually hired for weeding. Women, however, were not paid more for their speed in weeding. As a woman labourer in the field explained: ‘Men are slow [in

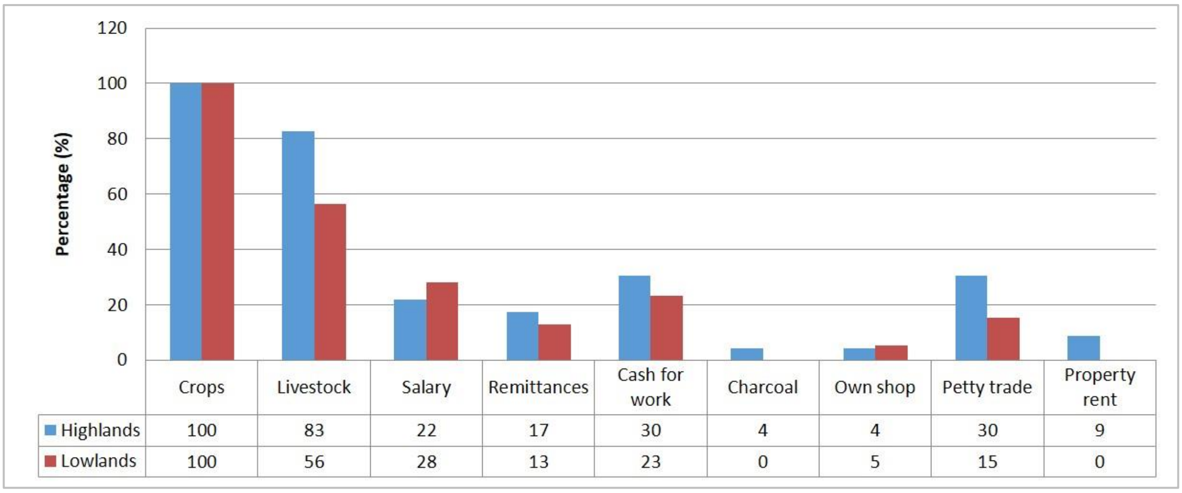
[34] Field observations and open conversations during scoping visit in 2015 and field data collection in 2016.

[35] By February 2016, the exchange rate was 27.5 birr/1 USD or 38.2 birr/1 GBP (www.xe.com accessed on 12/02/2018).

weeding], and they cannot work on in their knees [bent over] as women do.'[36] In some cases, farmers hired permanent labourers who they paid on a monthly basis. Only men were hired in this way; and they were usually hired by female landowners to plough and irrigate their land (usually at night), or to be guards for the command areas of the irrigation associations. Permanent wages ranged between 250 and 300 birr per month.

All survey respondents obtained income from crop sales. Also, livestock was a very important additional income; 83% of respondents from the highlands and 56% of those from the lowlands had livestock. This form of livelihood was followed by cash-for-work social support programmes, salaried work, petty trading, and the receipt of remittances from relatives working in cities in other parts of the country (see Figure 4.5 below).

Figure 4.5 Sources of income of respondents – Tigray



Source: Survey of farmers; January and February 2016, March 2018.

Food insecure households in the two *woredas* are supported by a governmental social support programme, called the Productive Safety Nets Programme (PSNP).[37] According to informants in the agricultural offices at the research sites, farmers with irrigated plots were not entitled to support from the PSNP.[38] Anecdotal observations from the fieldwork, however, showed that at least one farmer – with an irrigated plot in the lowlands – received

---

[36] Female farm labourer [E_Wa-Op-02] 26/01/2016.

[37] PSNP started in Ethiopia in 2005 to support food insecure households. The government support can be in the form of cash-for-work or food-for-work (HEA, 2007).

[38] Agricultural officer in Raya Azebo *woreda* (male) [E_Wa-ID-02] 27/01/2016.

PSNP. Additionally, up to six farmers from the highlands, including leaders of the water users associations (WUAs), did 'cash-for-work' for watershed rehabilitation[39]. This suggests flexibility in the implementation of this policy due to poor farming incomes.

The town centres of Maychew (in Endamehoni *woreda*) and Mohoni (in Raya Azebo *woreda*) have important farmer and livestock markets, which are easily accessible by public transport. Mekele, the regional capital of Tigray is an important market for agricultural products from the low plains of Raya Valley. Farmers mentioned two forms of commercialisation of their farm products: 1) taking products to district markets by themselves (e.g., on foot, by donkey and/or using public transport), and 2) participating in on-farm sales with traders. Both male and female household heads said that they were involved in the commercialisation of the agricultural products.

In summary, small-scale irrigation agriculture in Raya Valley is the most important livelihood strategy for the survey respondents. Farmers complement their incomes with proceeds from rainfed farming and livestock. Land access and irrigation water access are therefore vital for these communities. The following section more fully explores irrigated farming systems, land access and use, and communal irrigation water systems in the research locations of Tigray.

4.3.4. Small-scale irrigation agriculture in Tigray

This section discusses the role and significance of small-scale farming in the study localities of Tigray. In addition, crops and livestock small-scale productions, plus the main constraints for smallholders, are discussed. These are findings that emerged from the survey analysis. A similar account will be presented for Mendoza in section 4.4.4. These characterisations are important to contextualise access, participation and decision-making in irrigation, taking into account the preponderant role of agriculture in the livelihood strategies of communities in both locations.

---

[39] Personal observations during fieldwork. For example in survey: female farmer in the highlands [E_Em-S-05] 03/02/2016.

Farming history, land tenure and land use in the research areas of Tigray

In Ethiopia, and specifically in Tigray, the development of irrigation has been defined as a critically important strategy to overcome poverty, with a particular emphasis on small-scale irrigation (Gebrehiwot et al., 2015). In contrast to most of the Tigray region, the Raya Valley is a rich area in terms of soil quality, water resources and agricultural potential; however, rainfall is insufficient and too erratic to sustain the livelihoods of local communities in the area. As a result, supplementary irrigation has traditionally been a common practice in the area (Yazew et al., 2010). The use of groundwater for irrigation is growing fast, fostered by governmental programmes for irrigation expansion (this will be further discussed in section 4.3.6). The highland areas of this region suffer from several environmental challenges including deforestation, overgrazing, and consequently, acute soil erosion (Tesfay et al., 2014a).[40] Therefore, expansion of modernised irrigation systems is mostly located in the lowlands.

Most farmers interviewed for this study have lived in the area almost all their lives. In fact, the appearance of farming in the highlands, has been visible for longer than in the lowlands. Respondents from the highlands had farmed for an average of 22.15 years, while farmers from the lowlands had farmed their plots for an average of 10.8 years.[41] This is because irrigation development in the lowlands is relatively new.

Land ownership is of critical importance for rural Ethiopians to secure their agricultural livelihood strategies, plus also to define their positions in society (Melesse et al., 2018). Since the Ethiopian constitution of 1995, all land in the country belongs to the State that provides rights of use to any citizen willing to farm the land. These rights allow land holders to inherit and rent out land, but prevents them from selling or mortgaging it (Deininger et al., 2008). Land right certificates are commonly issued with the name of the head of household. This, traditionally, was a man; however, now, land can be registered jointly in the names of both spouses of a household. This is due to the recently implemented land

[40] This motivated the implementation of the Sustainable Land Management (SLM) Programme, funded by a number of international donors including the World Bank (2013; 2019), IFAD, EU, and the Governments of Germany, Canada, Norway and Finland, and executed by the Ministry of Agriculture and Natural Resources (MoANR) of Ethiopia (GIZ, 2015).

[41] These data are derived from the survey results in Tigray (2016-2018).

registration and certification programme; that is, the Second Stage of Land Registration and Certification (SSLR),[42] started in 2014 (Holden and Tilahun, 2017).

By the time of the fieldwork in 2016 Tigray, however, was the only region in Ethiopia that continued registering land in the name of the head of the household, most frequently a man, in spite of the SSLR (Melesse et al., 2018).[43] This may explain why out of all the farmers interviewed, holding land certificates (n=62), only 22.6% were women as sole owners of land, while 59.7% were male landowners. There were also 12.9% joint registrations and a remaining 4.8% who answered, 'did not know'. Berhane and Miruts (2015), alongside other researchers and previous field evidence,[44] corroborate that in Tigray, land right security is not being realised for all women who are entitled to it. Those who do have secured land rights are female heads of household. In fact, from the 12 surveyed cases of women holding land certificates in only their names, 11 were heads of households, and one[45] was a male-headed household with the wife present; she had inherited the land from her parents. In male-headed households, all the men claimed to own the land; thus, married men had land in their names only, but married women did not. Table 4.9, below, presents a summary of land tenure rights for the surveyed farmers by gender in the study location of Tigray. In regard to farmers with no land certificates in their own name, access to irrigation water is obtained through a spouse's water rights (e.g., two cases in the highlands), by leasing land (e.g., two farmers in the lowlands), or by using communal irrigated land (this was the case for six people who were members of an irrigation cooperative in Tsiga *kebele*).

[42] This SSLR of 2014 digitalised the parcel information (through georeferencing) and provided land right holders with maps of their plots, in addition to their certificates. This process was previously paper based, during the FSLR, with no maps provided.

[43] Personal communication with Prof. Holden and Prof. Tilahun indicated that the joint registration process was compulsory in the country, although there were regional variations (05/12/2017).

[44] Gender analysis conducted by the researcher for the GIZ Sustainable Land Management Programme, 2017.

[45] Male farmer respondent of the survey [E_Tsi-S-15].

Table 4.9 Land tenure of farmers participants by gender and location - Tigray

Land tenure of survey participants	Highlands	Lowlands
	Percentage (n)	
Farmers with land certificate (LC)	**92.9 (26)**	**81.8 (36)**
*% (n) LC in the name of women**	*23.1 (6)*	*16.7 (6)*
*% (n) LC in the name of men**	*50 (13)*	*66.7 (24)*
*% (n) LC as joint registration**	*15.4 (4)*	*13.9 (5)*
*Gender of LC holder unknown**	*11.5 (3)*	*2.8 (1)*
Farmers without land certificate (LC)	**7.1 (2)**	**18.2 (8)**
% Total respondents (n)	**100 (28)**	**100 (44)**

Source: Survey of farmers; January and February 2016, March 2018. Note: (*) from the total farmers with land certificate on their names.

A consideration of the existing gender gap in land tenure rights is fundamentally important to understanding the mechanisms women and men use to access irrigation water, the degrees of security of access, and their membership and participation in WUAs. These are themes to be discussed in the Chapters 5 to 8 of this thesis.

All farmers surveyed in the highlands had a mix of rainfed and irrigated land, while in the lowlands only 59% had rainfed land. In addition, 46% of farmers in the highlands, and 36% in the lowlands, have some space for livestock (see Table 4.10). In the Tigray Region, in 2014, the average land size of a peasant household was estimated at 1.19 hectare with wide variations according to the different areas of the region (WWDSE&CECE, 2014a). The average size of farms per household reported in this study (as per Table 4.10) was much smaller than those estimates, at 0.31 hectares of rainfed land and 0.22 hectares of irrigated land in the highlands; plus 0.74 rainfed hectares and 0.5 irrigated hectares per households in the lowlands. In this regard, it is important to consider that in recent years, farm sizes have shrunk (Holden and Tilahun, 2017).

Table 4.10 Type and size of production land by location - Tigray

Location	Rain-fed land for crop production	Irrigated land	Land for livestock
Highlands			
Percentage of farmers having this type of land (n)	**100 (28)**	**100 (28)**	**46 (28)**
Average land size in ha (n)	0.313 (28)	0.217 (28)	0.012 (13)
Lowlands			
Percentage of farmers having this type of land (n)	**59 (44)**	**100 (44)**	**36 (44)**
Average land size in ha (n)	0.738 (26)	0.499 ha (38)*	0.089 (16)

Source: Survey of farmers; January and February 2016, March 2018. Notes: (*) This average land size is calculated only for 36 farmers from the 42 surveyed. The other 6 farmers produced in a communal irrigated land belonging to a youth irrigation cooperative (Tsiga *kebele*).

The expansion of farming activity is restricted by government land policies. In the study localities within Tigray, the maximum farming area that a household is allowed to hold is two hectares of cultivable land and the minimum allowable land size is 0.25 hectare (WWDSE&CECE, 2014b). In addition, according to interviewees, it was difficult to find land for rent in the *kebeles* of the highlands[46] and in Tsiga *kebele*[47], in the lowlands. It seems that farmers interested, or able, to expand irrigated productions in the lowlands are instead able to engage more easily in long-term rental contracts.[48] Lease agreements between farmers must be approved by the local court (*tabia* court) (WWDSE&CECE, 2014b). Farmers being unable to expand land production by renting land, suggests that maximising production within their irrigated plots is of fundamental importance for the subsistence of smallholders in these areas.

Crop production

The study findings suggest that most of the small-scale agriculture in the study localities is based on a few crops. This limited crop diversification is due to low diversification in market preferences, the limited knowledge of farmers about alternative crop cultivation, and the restrictions imposed by seed availability in local markets. Both female and male farmers surveyed, were found to be growing similar crops.

The main rainfed crops grown in the Tigray research locations are sorghum, teff, barley, maize and, in lower proportions, beans, peas, *dekoko* (local pulse) and *chat*.[49] Also, typical irrigated crops include onions, tomato, cabbage, and green leaf salad crops – including chard and lettuce (WWDSE&CECE, 2014a). Data in table 4.11, below, show the proportions of farmers growing each type of crop in the irrigated and rainfed study areas.

---

[46] Individual interview with a female farmer in Tsibet *kebele* [E_Tb-Op-05], 26/01/2016; FGD with female farmers in Embahaste kebele [E_Em-G-01], 02/02/2016.

[47] In-depth interview with key informant (abomay, male) in Tsiga *kebele*, lowlands [E_Tsi-ID-02]. 25/01/2015.

[48] In-depth interview with a male farmer, member of a WUA in the lowlands [E_Wa-ID-01] 26/01/2016.; open interview with a female farmer in the lowlands [E_Wa-Op-03] 27/01/2016.

[49] Chat (*Catha edulis*) is a plant native from the Horn of Africa and the Arabian Peninsula used as stimulant due to its alkaloid content relate to amphetamines. It is commonly cultivated within Muslim communities in Ethiopia and broadly consumed (chewed) mainly by men. It is said to be highly addictive. Source: WHO (2008).

Table 4.11 Irrigated and rainfed crops most frequently included in crop rotations - Tigray

Highlands				Lowlands			
Irrigated crops	**%**	**Rainfed crops**	**%**	**Irrigated crops**	**%**	**Rainfed crops**	**%**
Potato	79	Wheat	88	Onions	79	Maize	71
Sasella	71	Maize	58	Tomato	62	Teff	67
Carrot	67	Barley	42	Papaya	40	Sorghum	55
Onions	21	Pulse	17	Mango	29	Wheat	38
Tomato	5	Sorghum	4	Cabbage	19		
Garlic	5	Teff	4	Salad	19		
Papaya	5			Avocado*	17		
Orange	5			Coffee*, gishu and pepper	14		
				Potato	7		

Source: Survey of farmers 2016-2018. Note: the percentages correspond to the proportion of farmers found growing these crops from all the respondents; (*) only in Tsiga *kebele*.

In the highlands, participants in the survey had a mix of an average of six crops in their irrigated plot rotations. The observed crop rotations mostly included potato, *sasella* (a local rhizome used for dying skin), carrots, cabbage and onions. Few farmers were found growing pulse crops; whereas, in the rainfed plots, most farmers grew wheat, maize, barley and pulse crops.

In the lowlands, surveyed farmers in irrigated plots were found to have a mix of an average of five crops, including onions, tomatoes, cabbage, greens for salad, and maize. This was confirmed by agricultural experts.[50] In some areas of the lowlands, fruit trees (of recent introduction) were also grown including mango, papaya and avocado. In rainfed plots of the lowlands, farmers cultivated maize, teff, sorghum and wheat. In rainfed plots of the lowland *kebele* of Kara Adishebo chat production was reported to be important[51]. The government prohibits its cultivation on irrigated land. Chat has a very high market price, which makes it very attractive to many farmers.[52] None of the farmers interviewed said they had chat on their rainfed land.

Constraints in small-scale irrigated farming

Small-scale crop production in Raya Valley is constrained by diverse factors. In the study locations, farming was based on traditional techniques with poor agronomic practices, and

[50] In-depth interviews to sub-district Agriculture Office Head (male) [E_Ka-ID-01] 26/01/2016; agricultural officer (female) [E_Ka-ID-02] 02/05/2016, Kara Adishebo *kebele.*

[51] Agricultural officer (female) [E_Ka-ID-02]

[52] Agricultural officer (female) [E_Ka-ID-02]

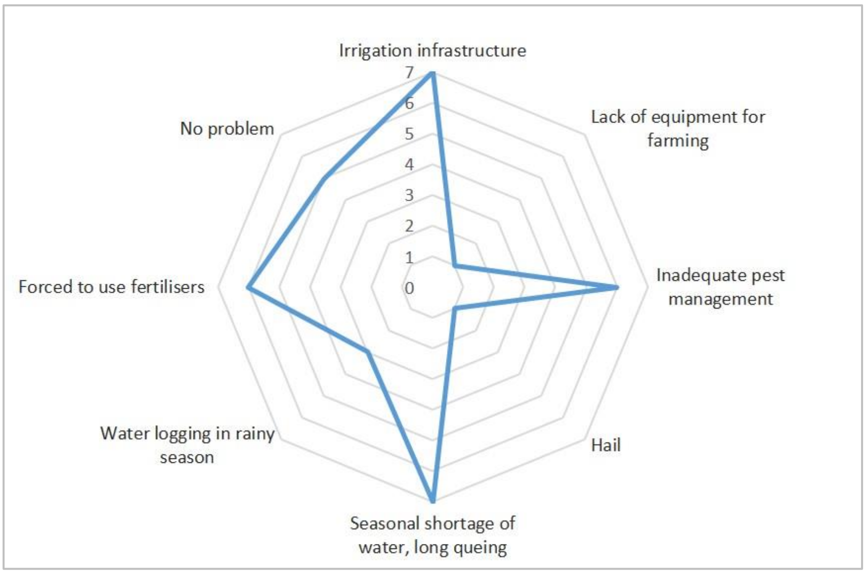
insufficient and poorly equipped extension service support. Market constraints (low market prices) and the high cost of inputs affect farming profitability. Prices of products are not determined by market demand and supply, but rather by brokers and merchants who collect products from farms at reportedly disadvantageous conditions for farmers (Tesfay et al., 2014b). Fertiliser, sold by the government, was used widely. Soil testing was not used to determine the amount of fertiliser required; instead a prescribed amount per hectare, uniform to all soil and climate conditions, is used.[53] In addition, governmental intervention through farming policies was reported to constrain and distort small-scale productivity and profitability. For example, in some WUAs, farmers reported being penalised for not rotating crops seasonally and/or for not sowing in rows.[54]

For a characterisation of specific farmers' constraints in the highlands and lowlands areas of the study, farmers were asked (in the survey) to identify their major constraints in irrigated farming. This question did not only help to characterise their farming conditions and contextualise their agricultural livelihood strategies, but it also served to identify farmers' priorities and perspectives in regard to production problems. This was important, as it contributes to better understanding of how agricultural problems interrelate with irrigation practice. Farmers' responses and frequencies of those responses are presented in Figures 4.6 and 4.7 below. While a number of highland respondents claimed to not have significant problems, e.g., 22% in irrigation, the large majority of lowland farmers described diverse problems – with only 4% in irrigation saying they had no problems.

[53] Agricultural officer (female) [E_Ka-ID-02]

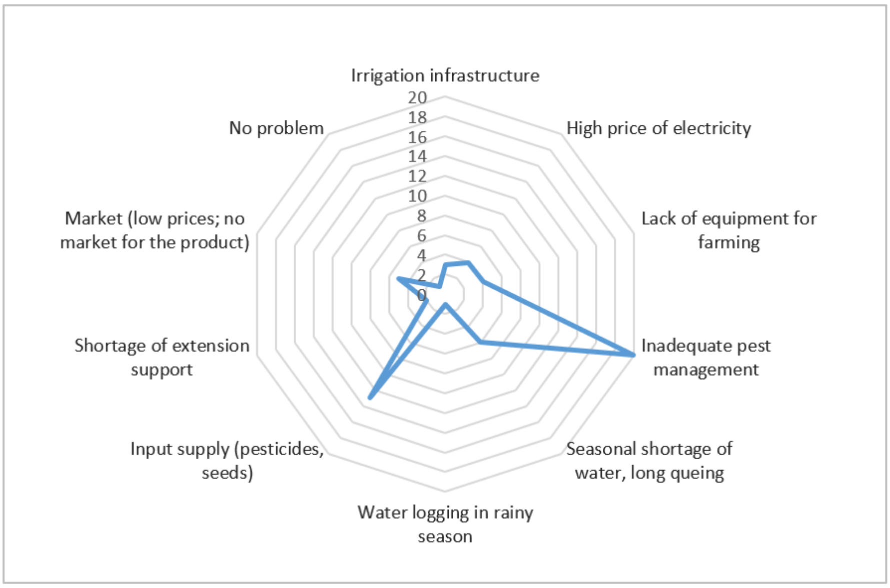
[54] For examples: Female farmer in the lowlands [E_Wa-Op-04] 26/01/2016; FGD with male farmers/WUA members [E_Wa-G-01] 30/01/2016.

Figure 4.6 Constraints in irrigated farming in the highlands of Tigray



Source: Survey of farmers 2016-2018. Frequencies calculated according to number of responses from surveyed farmers. N=23.

Figure 4.7 Constraints in irrigated farming in the lowlands of Tigray



Source: Survey of farmers 2016-2018. Frequencies calculated according to number of responses from surveyed farmers. N= 25.

The results in Figure 4.6 for the highlands and Figure 4.7 for the lowlands and based on survey responses, show the critical factors constraining farming in these study areas. Those results were also discussed in FGDs and in-depths interviews with farmers and experts, and thematically identified during the analysis as shown in Table 4.12. In comparing both sets of responses, the results indicate that the major constraints on profits from farming in the lowlands were related to inadequate pest management and the high cost of irrigation water (groundwater). This expense is due to electricity costs and that of maintenance of equipment. Other important factors mentioned were the lack of skills and of spare parts for repairing water pumps. In addition, the difficulties associated with accessing agricultural inputs were also described as important profit constraints for this kind of intensive farming. In the highlands, the most critical issues determining profits for farmers were linked to access to water, and the effort and availability of work required for the maintenance of the irrigation infrastructure (i.e., earthen channels and water reservoirs). On the other hand, in the highlands, cultivated plots were smaller than in the lowlands, so productions were less intensive in their use of inputs (e.g., improved seeds, and pest management); therefore, the required production capital seems to be less critical here than in the lowlands.

Table 4.12 Illustrative cases of key farming constraints in Tigray indicated by study informants in FGD and individual interviews and thematically identified during the analysis

Key farming constraints identified	Illustrative cases
Irrigation infrastructure maintenance limits access to water in the highlands and profits in the lowlands.	'We need [lined] canals. Water evaporates and it is lost. We are wasting our water. We have sediments and need to clean every time. We spend a lot of labour on cleaning.' [Male WUA leaders, highlands. E_Tb-G-02, 03/02/2016]. 'Pumps are damaged very often, last month, one motor was destroyed, and every farmer had to collect money, 300 birr per year as reserve for the pump.' [Male WUA leaders, lowlands. E_Wa-G-01, 30/01/2016]. 'We don't have the capacity to repair the pump. It is often broken.' [Male *abomay*, lowlands. E_Wa-ID-03, 06/02/2016].
The fertiliser programme	
has created uncertainty on land ownership in the highlands	'I can prepare compost myself. But I have to apply fertilisers. It is mandatory for all people. If someone doesn't apply [fertilisers] they [government] are going to take the land and give it to another farmer who uses fertilisers.' [Female farmer in the highlands. E_Tb-Op-02, 04/02/2016].
makes agriculture not viable when profit margins are too small	'Now members [from an irrigation cooperative] are decreasing. They don't want to use fertilisers, so they don't want to be members' [Male *abomay* lowlands, E_Tsi-ID-02, 05/02/2016].
constrains rainfed agriculture in the highlands and lowlands.	'I don't need to use fertiliser from the kebele. I can use manure. With access to water it is ok, but the problem is in rainfed land. There is not enough water and we are forced to use fertilisers.' [Male, elder farmer, lowlands, E_Wa-ID-01, 26/01/2016].
The lack of knowledge about pest management and the difficulties to access cost-effective solutions diminish yields and therefore profits in the lowlands.	'We don't have access to good products, [improved] seeds [resistant varieties], and pesticides for crops.' [FGD female irrigators, head of households, lowlands, E_Ka-G-02, 05/02/2016].
High costs of electricity for pumping water and lack of spare parts for pumps greatly diminish profits in the lowlands.	'Farmers have trouble to operating irrigation correctly. Before, it [cost of electricity] was OK. Now many are not able to pay the bill, it is too expensive.' [Male *abomay* WUA, lowlands, E_Wa-ID-03, 06/02/2016].
The lack of market information and advice on marketing options constrains profits.	'All farmers plant the same [crop] in one season. Then they don't have market.' [Female agricultural expert, E_-Ka-ID-02, 05/02/2016].
Access to knowledge is differentiated according to gender and position in the household.	'Only men or women heads of households are called for training. They [women] don't participate in training. This is their tradition. Men cannot stay at home and they go to training.' [FGD female farmers, non-household heads, highlands, E_Em-G-03, 15/03/2018]. 'If they don't have husband or are divorced, women can go [to trainings]; but if the husband is around, he goes. Even the list is made with the name of the husband. The expert informs husbands, not wives.' [Better-off female farmer, lowlands, E_Wa-Op-03, 27/01/2016].

Sources: In-depth interviews and FGD with farmers of Tigray 2016-2018.

The issue of the compulsory purchase and use of fertilisers emerged in the analysis of irrigation farming constraints; however, the outcomes of this policy appear to be mixed. In the lowlands, farmers needed to purchase fertiliser, which is only sold by the government, in order to receive irrigation water (i.e., groundwater). Therefore, security of access to irrigation water was dependent on farmers' financial capacity to purchase those fertilisers. In these lowland areas, farmers stated they were satisfied with the use of fertilisers, as their plots are relatively larger than those in the highlands, plus the crops planted have higher market value. Surveyed farmers, however, complained about being forced to apply fertiliser even on the rainfed plots, where they cannot control water availability. In addition, some farmers complained about their lack of flexibility to select the farming practices that suit them best (see Table 4.12 below). For example, a female agricultural expert in Kara Adishebo *kebele* says,

> After many discussions, they [farmers] accept the rules [to purchase and apply fertilisers]; sometimes, especially those farmers who rent land, they complain. But those that are landowners understand it is important. Experts must convince them [E-Ka-ID-02, 05/02/2016].

In the highlands, some farmers doubt the need for inorganic fertilisers, thus, say: 'Our land is very fertile and we are forced to apply fertilisers',[55] while others feared they would lose their land due to non-compliance (see Table 4.12). Other inputs such as pesticides and improved seeds were also provided by the government; however, farmers preferred to purchase those inputs from private vendors to ensure better quality[56].

As the findings from this study reveal, these agricultural policies were found to interfere in the self-governance of the communal irrigation schemes because they affect security of access to irrigation water, as well as security of livelihood strategies (see Chapters 6 and 7 for further details).

Livestock production

Livestock is of critical importance in rural livelihoods of Ethiopia. It contributes to food security, draft animal power to plough land, fetching water and firewood, and as a safety net

[55] FGD male WUA leaders [E_Tb-G-02] 03/02/2016.

[56] Individual interview to male farmer, lowlands [E_Ka-Op-01] 05/02/2016.

in communities with poor access to credit and bank services. Typical animals reared in Tigray include cattle, sheep, goats, and chickens (Tesfay et al., 2014b). In the lowlands, camels are common. Oxen are typically used for draft and donkeys and mules for other duties such as fetching water, animal fodder and firewood.

Within the survey participants, 96% of farmers in the highlands had at least one type of livestock (with only one farmer having no animals), while 88% in the lowlands had the same (with only five farmers having no animals). The most common livestock owned by women in the highlands were sheep. And in the lowlands, it was cattle for milk (see Table 4.13 below). In Kara Adishebo *kebele*, livestock is an important resource, especially cattle for milk.

Table 4.13 Percentage of surveyed farmers owning livestock by animal type and the number per household

	Type of livestock	Cattle	Oxen	Sheep	Goat	Donkey	Camel	Poultry
Highlands								
Male	% of farmers having livestock (n)	95 (19)	90 (18)	55 (11)	25 (5)	60 (12)	5 (1)	70 (14)
	Average no. of animals per HH	3	1.5	8.1	5.2	1.7	2	5.4
Female	% of farmers having livestock (n)	25 (2)	50 (4)	63 (5)	0 (0)	0 (0)	0 (0)	38 (3)
	Average n. of animals per HH	1	1	5	0	0	0	6
Lowlands								
Male	% of farmers having livestock (n)	81 (25)	77 (24)	26 (8)	13 (4)	16 (5)	3 (1)	45 (14)
	Average no. of animals per HH	4.1	2	5.4	5.5	1.2	3	4. 8
Female	% of farmers having livestock (n)	54 (7)	46 (6)	23 (3)	15 (2)	0 (0)	0 (0)	54 (7)
	Average no. of animals per HH	2.6	1.5	3	4	0	0	11.6

Source: Survey of farmers 2016-2018.

Highland and lowland farmers with livestock shared similar constraints for their animal productions.[57] In both locations, the most critical issues mentioned were shortage of fodder, due to rain shortage, and a recent policy that had enclosed free grazing areas. This policy restricted farmers' available space for keeping animals, especially during the day. This was

[57] Sources: Survey of farmers 2016-2018.

reported to have forced farmers to reduce or even abandon livestock productions.[58] Additionally, incidence of animal diseases was mentioned as a serious constraint, especially because veterinary services were observed to be deficient. In the lowlands, the problems highlighted included the lack of water points for animals and the high price of animal feed. Since livestock production is of high significance for rural communities, serving as a safety net, and for draft, the implementation of this policy was a contentious matter by the time of the fieldwork.

4.3.5. Water resources in Tigray

The legal framework for water resources in Ethiopia establishes that 'all water resources of the country are the common property of the Ethiopian people and the state' (MWIE, 2000: 1252; art. 5). Water resources in Ethiopia are under the Ministry of Water, Irrigation and Energy; however, water resource management is under the jurisdiction of the regional governments. In Tigray, the highest level supervisory body for irrigation is the Tigray Bureau of Water Resources and Energy. There are also lower level administrations in correspondence to the administrative boundaries (i.e., zone, *woreda* and *kebele*). The main responsibilities of the Water Bureau and lower level offices are to design and implement hydraulic infrastructure and its maintenance. However, at the local level, the Bureau of Agriculture administers irrigation water and supports the constitution of the WUAs. This separation of responsibilities was found to limit the involvement and knowledge of the Water Bureau, regarding WUAs activities and needs.[59]

Drinking water

Securing drinking water for the households is usually the responsibility of women in rural areas of Ethiopia. For example, a previous study in Tigray found that in 88.2% of the times water was fetched for household use, were female members of households found doing the activity (Ebato and Van Koppen, 2005). Additionally, girls and boys were found to be helping women in this task. This is a critically important issue as it determines the workload

---

58 Examples from survey respondents: [male, 53 years old, E_Em-S-03, 02/05/2016]; [female, 40 years old, E_Em-S-05, 02/02/2016]; [male, 35 years old, E_Em-S-08, 05/02/2016]; [male, 30 years old, E_Em-S-09, 05/02/2016]; [male, 60 years old, E_Tb-S-07, 03/02/2016]; [male, 32 years old, E_Tb-S-09, 03/02/2016].

59 Personal observations during in-depth interviews with Water Bureau officials for the fieldwork. For example: Head of Water Planning Department, Water Bureau, Mekele (male) [E_Mk-ID-01] 11/01/2016; Water Supply coordinator, District Water Office, Maychew (male) [E_May-ID-01] 13/01/2016.

of particular family members, especially women; thus, their availability to take part in irrigation water management activities. This issue will be explored in detail in Chapters 6 and 7.

In all rural and urban areas of Endamohoni *woreda,* in the highlands, drinking water supply coverage was reported to be 77% in 2009, with the average walking distance of 20 minutes to fetch water (Admasu et al., 2011).[60] Drinking water supply and sanitation were reported to be deficient in Raya Azebo *woreda*, in the lowlands (WWDSE, 2015). This was confirmed during fieldwork for this study.

In the research locations, only 7% of households surveyed had their own water source in the compound (all being in the lowlands). The vast majority of households used communal water sources. In the highlands, no differences were reported regarding the source of drinking water used during the dry and rainy seasons; most respondents used water from springs (see Table 4.14 below). Drinking water from springs was indicated to be of good quality and households were found drinking it without water treatment such as chlorine or boiling.[61] From the respondents of the highlands using spring water, 67% reported walking 5 to 20 minutes to the closest water point; 24%, less than 5 minutes; and 10% only indicated a walking time of 30 minutes. Walking time to the boreholes was 15 minutes for the two households using this source.

Table 4.14 Drinking water sources reported by households in the highlands - Tigray

Drinking water sources used in the highlands (n=28)	Percentage of respondents (n)
Spring	84 (21)
Borehole	8 (2)
Hand pump	4 (1)
Distributed by the kebele	4 (1)

Source: Source: Survey of farmers 2016-2018.

In the lowlands, from all respondents not having their own water source (93%) (Table 4.15), 70% used water directly from the river, open canals, springs or from the irrigation deep wells. Informants indicated that households did not use water treatments[62]. The rest of the

60 An average walking distance of 1.5 km from household to water points was said to be the maximum planned distance for drinking water infrastructure supported by the Water Office. Source: Interview with irrigation expert, highlands (female) [E_Tb-Op-04] 15/03/2018.

61 Irrigation expert highlands (female) [E_Tb-Op-04] 15/03/2018.

62 Irrigation expert lowlands (female) [E_Ka-ID-02] 05/02/2016.

respondents reported using water from community wells (21%) or that distributed by the *kebele* (10%). No differences between drinking water sources used during dry and rainy season were reported; however, some respondents indicated complementing the main source used during the rainy season with other sources.[63] For most of respondents (76%), the water point used for domestic water was nearby with a walking distance of less than five minutes. For the rest of respondents, walking time was less than 20 minutes (for two people) and between 30 to 60 minutes (two people). Community hand-wells were administered by community users' organisations for drinking water.[64] Prices charged to households varied according to the location and the use of water (i.e., for human or animal use).[65]

Table 4.15 Drinking water sources reported by households in the lowlands - Tigray

Drinking water sources used in the lowlands (n=42)	Percentage of respondents (n)	Complementary sources reported to be used during the dry season
Own drinking source	**7 (3)**	
Not own drinking source	**93 (39)**	
Directly from the river	*28 (11)*	1 person uses harvested rainwater 1 person uses water distributed by the *kebele*
Irrigation deep well	*26 (10)*	
Community well	*21 (8)*	
Open canal	*13 (5)*	3 people reported complementing with water brought from town (by donkey or tanker)
Distributed by the kebele	*11 (4)*	
Spring	*3 (1)*	

Source: Survey of farmers 2016-2018.

Irrigation water

In Raya Valley, surface water resources are composed of perennial rivers and streams that originate through rainfall in the highland areas, most of which disappear in the central part of the valley (WWDSE, 2015). During the dry season, the streams run with low flow and are entirely used for small-scale farming under traditional irrigation schemes; whereas,

[63] For example, in Tsiga *kebele*, where households reported using water from the river or diversion canal, a key informant indicated that water shortages were generally experienced during the dry season, up to April or May. In those cases, they would bring water from Mohoni, the *woreda* centre (a distance of about 4 km from the *kebele* centre). Interview with *kebele* administrator (male) [E_Tsi-ID-03] 30/01/2016.

[64] These associations are different from the irrigation water users' associations and were not investigated in this study. In Wargba *kebele*, a couple of irrigation users' associations also managed potable water.

[65] For example, in Warga *kebele*, surveyed farmers and *abomay* from the irrigation WUA Alem Wargba indicated paying 5 birr/25 l of jerry can [E_Wa-ID-03] 27/01/2016; FGD with male farmers from the WUA Lemlem Wargba reported paying 30 cents/25 l of jerry can and 5 birr/month for 1 cow [E_Wa-G-01] 30/01/2016.

during the rainy season, streams become flash floods (MoWR, 2014). A small number of streams run throughout the year in the southern part of the region. There are no perennial rivers and streams in the plains of Raya Valley (MoWR, 2014). The main rivers in Endamohoni *woreda* are Gereb Ayni, Hara, Nai Muq, Awdey and May Chumachil (Admasu et al., 2011). This diversity of water sources results in different types of hydraulic infrastructure and WUA types. This will be discussed in detailed in section 4.3.6.

In regard to groundwater resources, the aquifer is recharged by rainfall and runoff from the perennial river systems. Groundwater tables are located between 0 and 20 metres in the Alamata sub-basin and from 20 to 60 metres in the Mohoni sub-basin (Hagos, 2010). Existing information regarding groundwater flows, reservoir replenishment and potential, as well as the impact of its use in agriculture, is scant; however, there is a rapid rate of well drilling (Hagos, 2010; Hailu Kahsay, 2018), which may compromise resource sustainability in the future.

4.3.6. Irrigation governance systems in the study areas of Tigray

The legal framework for irrigation systems in Ethiopia considers two types of irrigation and drainage systems (MWIE, 2014: 7625), as follows:

(a) 'Traditional irrigation and drainage systems': defined as 'an irrigation and drainage system constructed by farmers using their own indigenous knowledge and locally available materials'.

(b) 'Modern irrigation and drainage systems': defined as 'an irrigation and drainage system constructed on the basis of a formal study and design or a modernised irrigation and drainage system'.

In the study locations, traditional and modernised spate irrigation systems, as well as pressurised irrigation systems, were found. Drip and sprinkler irrigation was only found in the lowlands.

Spate irrigation*[66]*: In Raya Valley, the spate irrigation infrastructure varies from traditional intakes and canals made by locally available construction materials (mainly shrubs) to

[66] This is a traditional antique practice of supplementary irrigation based on diverting floods from upstream catchment areas after a short duration, heavy rainfall, from ‘wadi’ channels through canals and spread on cropping fields enclosed by bunds; the irrigation systems is based on infiltration of water that remains in the crop profile for longer periods of times, and on sedimentation for managing soil fertility (Yazew et al., 2010).

systems that include diverse levels of modernisation such as permanent structures (e.g., concrete diversions and/or gabion or masonry structures) and sediment management with machinery (Yazew et al., 2010). Spate irrigation schemes are constrained by unpredictable occurrence and amount of rainfall, which demands the establishment of rules among farmers to regulate and ensure access and use of irrigation water. Additionally, its functioning and maintenance demand high investment in labour, which means that the system is usually used and maintained by groups of farmers organised collectively. The dominant form of organisation is the WUA, generally composed of community members who use spate water from the same river and diversions, and have the will to form an association (Yazew et al., 2010).

Pressurised irrigation systems: During the fieldwork for this study, a government programme[67] was under implementation. This programme aimed to develop 18,000 hectares of pressurised irrigation agriculture using groundwater resources from the lower plains of the Raya Valley (Hagos, 2010; WWDSE, 2015). Up until August 2015, there were 32 functional deep wells from the 312 constructed by the project.[68] Farmers abstracting water from a deep well must constitute a WUA. Each WUA is represented by a water committee formed by a minimum of five and a maximum of 12 farmer representatives. These are people elected by the community of water users (MWIE, 2014). During fieldwork in 2016 and according to interviews with officials of the district agricultural office, only 15 WUAs were reported to be functional in the lowlands;[69] what was confirmed by the Head of the Agricultural office[70] in a follow-up field visit in 2018. This is an indication of the fragile viability of those WUAs (for further discussion see Chapter 7).

Water users' associations in Tigray

In Tigray, all survey respondents were organised in different types of WUAs in order to access and use traditional or modernised irrigation schemes. Worldwide, WUAs are the core

---

This traditional system is used in arid areas, which are usually marginalised ecologically and socio-economically and mainly used to practice subsistence farming.

67 Raya Valley Development Project (RVDP). Drip and/or sprinkler methods are used (field observations from this study). Personal communication with an official of the *woreda* Water Office in Mohoni, Raya Azebo (male) [E_ Mh-Op-01] 25/01/2017.

68 Irrigation expert from Agricultural office, Raya Azebo *woreda* (male) [E_ Mh-Op-01] 25/01/2016.

69 Irrigation expert from Agricultural office, Raya Azebo *woreda* (male) [E_ Mh-Op-01] 25/01/2016.

70 Head of Agricultural Office, Raya Azebo *woreda* (male) [E_Mh-ID-01] 14/03/2018.

element of self-governance of communal irrigation water resources. The promotion of WUAs took off in the 1980s with the decentralisation and devolution of irrigation management, which sought to devolve management of irrigation systems from governments to farmers (Uphoff, 1986; Garces-Restrepo et al., 2007). Establishing WUAs became mandatory in the course of donor-financed irrigation development. In this study, WUAs are the unit of analysis, and their relevance and functioning will be analysed in detail in Chapter 7.

a. Legal framework for WUAs

In 2000, the formation of WUAs was 'encouraged' by a then existing legal framework on water resource management (Proclamation 197/2000) (MWIE, 2000, art. 27: 1259); however, it was not until 2014 that a proclamation provided detailed stipulations for the establishment of irrigation WUAs within a context of decentralisation and the transfer of irrigation and drainage services to users (Proclamation 841/2014) (MWIE, 2014). The implementation of this proclamation served several purposes in regards to rights and duties of water users: (1) that water users assume responsibility for the operation, management and maintenance of the irrigation systems in their service areas; (2) that they protect the system from damage derived from water use, including 'erosion, salinity and pollution'; (3) that they define internal rules for the association's functioning, and amount of water distributed to users; and (4) they collect fees from members (MWIE, 2014: 7627). Cost recovery and efficient use of the water resources are also listed. The Proclamation further establishes that training in irrigation should also be part of the associations' objectives. Particular emphasis is given to the promotion and implementation of modern irrigation systems as a key strategy for food security. The 2014 Proclamation stipulates principles of equity, and of non-discrimination based on differences related to race, gender, religion or other categories, in order to participate in any irrigation WUA. Although in interviews with the regional Water Bureau it was mentioned that WUAs have a quota of women participating in water committees, this was not verified on the ground. In most of the WUAs interviewed (except one in the highlands), interviewees said they did not have to fulfil a gender quota for women. Moreover, the 2014 Proclamation does not mention a female quota for participation and management of WUAs.

WUAs in Tigray are characterised by a high diversity with effect on the different types of governance systems observed. There are two defined groups of formal irrigation users' organisations: irrigation WUAs (described in this research as 'WUAs') and irrigation cooperatives (denominated in Tigray as water committees). In addition, informal WUAs were found managing traditional irrigation and drainage systems. Typically, a formal WUA is represented by a management board of members called a 'water committee'. During the fieldwork, it was observed that extension officers found these diverse types of WUAs and the nomenclatures confusing.[71] Usually, different WUAs were considered to be the same type. This confirms previous observations of problematic governance of irrigation schemes due to unclear differences between the roles of agricultural cooperatives and WUAs (Yami, 2013). This problem was to be corrected with the arrival of the WUA Proclamation of 2014.[72]

The 2014 Proclamation indicates two alternative ways of constituting an irrigation WUA: (1) by 'the will of interested persons' (MWIE, 2014: 7629) and (2) by 'the supervising body' in consultation and agreement with 'potential members of the association and relevant stakeholders' (MWIE, 2014: 7632). Persons and associations allowed to form an irrigation WUA and to claim a water permit may include (MWIE, 2014) the following:

- Persons possessing land and using water supplied by a traditional irrigation and drainage system.
- Persons possessing land and using water supplied by a modern irrigation and drainage system.
- An association formed to manage a traditional irrigation and drainage system.

According to this Proclamation, once the association is formed, all water users possessing land and wanting to irrigate within the association's service area must become members; thus, all rights and duties derived from the formation of an association become inherent to the land for the length of existence of the WUA.

The Proclamation also establishes that a person who uses land within the command area of an association through a lease contract longer than three years must be part of the WUA, and

---

[71] Water Bureau official, Maychew (male) [E_May-ID-01] 13/01/2016;, irrigation experts Maychew Water Bureau (female) [E_Em-Op-01] 02/02/2016; [E_Tb-Op-01] 04/02/2016; REST Tigray (local ONG), Mekele (male) [E_Mk-ID-03] 08/02/2016.

[72] Irrigation WUAs are established and managed pursuant to Proclamation 841/2014 under the jurisdiction of the Ministry of Water, Irrigation and Energy (MWIE); in contrast, irrigation cooperatives are managed under the legal regulations of the Ministry of Agriculture.

remain a member, until the period of the lease has expired. The lessee must receive written authorisation from the land owner to exercise all membership rights and obligations (MWIE, 2014).

The consideration of the different legal types of water rights and membership in WUAs is important to characterise mechanisms of participation and its effects in rule enforcement and equality (see Chapter 7 and 8 for further discussion).

b. Irrigation WUAs in the highlands

All irrigation water used in the highlands is surface water, thus, distributed and used through a wide variety of hydraulic infrastructure, including boreholes, hand-dug wells, earth and lined canals, and water reservoirs locally called '*ellas*' (see Figure 4.8). According to local informants,[73] all people with land have the right to irrigation water and to WUA membership. Participation in a WUA is voluntary. Farmers are also allowed to dig their own reservoirs to collect rainfall water; this is important in order to cope with rainfall shortages and unpredictability. Only farmers with sufficient land and labour are able to dig their own pods. Table 4.16 summarises the WUAs existing in the study locations in the highlands.

Figure 4.8 Traditional stone water reservoir (left) and concrete water reservoir (right) in Tsibet, Tigray

Source: Fieldworkd in Tigray, Tsibet *kebele,* highlands. February 2016.

[73] Head of Water Supply Office, Maychew Water Office (male) [E_May-ID-01] 13/01/2016.

Table 4.16 WUAs of Embahaste and Tsibet *kebeles*

Embahaste *kebele*		
Kushet	**Water structures**	**Nº of WUAs**
Duqua	2 reservoirs (*ellas*); 2 canals; 24 boreholes	8
Bolenta	spring; reservoir	1
Adistgaba	2 canals that feed a large reservoir; river; individual and communal boreholes	1
Kolla	3 reservoirs; canal for modern spate irrigation (reservoir; check dam; canal)	4

Source: Kebele irrigation expert [E_Em-Op-01] 04/02/2016.

Tsibet *kebele*		
Kushet	**Water structures**	**WUAs**
Belago	river	Garab Lafi
	spring	Chenty May
	3 boreholes	3 informal assoc.
Shamat	1 canal/1 WUA	formal WUA
	Many boreholes - 7 m deep; 8 m diameter; diesel pump	Informal WUAs; 3 persons per borehole on average. Between 1-5 depending on borehole capacity
Gerhaile	Spring; big reservoir; furrows to farms	1 committee
	many boreholes	several informal
Lalaisebet	2 springs; 2 reservoirs	
	Many private boreholes	

Source: Kebele irrigation expert [E_Tb-Op-01] 02/02/2016.

c. Irrigation WUAs in the lowlands

In the lowlands, irrigation management organisations vary according to the type of water resources used, which is dependent on the locality. The study collected data from WUAs in three lowland *kebeles*: Tsiga, Wargba and Kara Adishebo.

In Tsiga *kebele*, farmers use surface water for irrigation. In this area, water comes from a spring in Maychew (highlands) and it is distributed by a recently constructed diversion canal that supplies water to Tsiga and Genet *kebeles* (see Figures 4.9 and 4.10).[74] According to the leader of the overall WUA, Lemlem Wenale association, the number of water users was growing and therefore, they believed that there was less water available for them.[75]

[74] This diversion canal was constructed by the SLMP project (GIZ) in 2015.
[75] Interview to abomay of Lemlem Wenale WUA Tsiga *kebele* (male) [E_Tsi-ID-02] 05/02/2016.

Figure 4.9 Diversion canal in Tsiga *kebele* transporting water from Maychew (highlands)

Source: Fieldwork in Tsiga *kebele*, January, 2016.

Figure 4.10 Communal field cultivated by the Ra'e cooperative, Tsiga kebele, Raya Azebo

Source: Fieldwork in Tsiga kebele, January, 2016.

There are two irrigation areas in Tsiga *kebele*, one in Gugic and one in Wenale *kushets* (see Table 4.17). Farmers from Gugic use irrigation water from a spring and four water reservoirs. Here, there are three water associations that in total irrigate five hectares. Farmers from Wenale irrigate from a diversion canal that transports water from the highlands. In Wenale, there is an overall WUA, Lemlem Wenale, led by an *abomay*[76] who supervises five WUAs. Each of these associations is also supervised by its own *abomay*. Most surveys for this research were conducted in WUAs of Wenale *kushet.*

Table 4.17 Study location Tsiga *kebele*

<table>
<tr><th>Kushets</th><th>Water structures</th><th colspan="3">Water users' associations</th></tr>
<tr><td>Gugic</td><td>- Diversion canal
- Spring
- 4 water reservoirs</td><td colspan="3">3-5 ha; 20 members</td></tr>
<tr><td rowspan="2">Wenale</td><td rowspan="2">Diversion canal</td><td rowspan="2">Lemlem Wenale</td><td colspan="2">Lemlem Freweny - 35 ha, 82 members</td></tr>
<tr><td>Ra'e
Freweny
Gueni
Mabel</td><td>Ra'e irrigation cooperative - 2 ha, 54 members</td></tr>
</table>

Source: Abomay WUA Lemlem Wenale [E_Tsi-ID-02] 05/02/2016.

The Ra'e cooperative is composed of four irrigation groups (see Table 4.18): Ra'e, Freweny, Gueni and Mabel. Members of those groups are landless, youth farmers who started producing collectively on a farm allocated by the government in 2013. Each group has one *abomay*; from those four water leaders, one is elected as the leader for the 'mother' irrigation cooperative (Ra'e). The two hectares available for these 54 households were reported by survey respondents to not be sufficient for the income needs of all those families. Farmers interviewed, however, indicated that this activity was better 'than having nothing.'[77]

Table 4.18 Ra'e irrigation cooperative in Tsiga *kebele*

Ra'e cooperative	Total members	Male	Female
Ra'e	14	5	9
Freweny	14	6	8
Gueni	12	4	8
Mabel	14	6	8
Total	**54**	**21**	**33**

Source: Abomay WUA Lemlem Wenale [E_Tsi-ID-02] 05/02/2016.

In areas where only groundwater is used for irrigation, each borehole must be managed by a formal WUA (see Figure 4.11), according to the regulations for modern irrigation schemes (MWIE, 2014). This is the case of Wargba and Kara Adishebo *kebeles*. An interview with

[76] *Abomay* is the local word for the WUA leader and it can be translated as 'the father of water'.

[77] Interview with *abomay* Ra'e cooperative (male) [E_Tsi-ID-02] 05/02/2016.

an officer from the *kebele* agricultural office in Wargba[78] was illustrative of the land distribution process in the region and the creation of WUAs. This officer explained that land was first allocated to farmers in this area in 1990. The borehole was defined and drilled in 2009. During the design of this irrigation scheme, land was divided into blocks of 0.25 hectare each. The minimum land a farmer can cultivate is one block, and the maximum, eight blocks.

Figure 4.11 Deep well (left) and irrigation system in Alem Wargba WUA (right) in Wargba *kebele*

Source: Fieldwork in Tsiga kebele, January, 2016.

After having the borehole, all water users needed to select the water committee. The criteria used were that farmers should have good potential to lead other farmers, thus be ‘model farmers’. They should also be responsible and transparent, and they should be well respected by the community. When a new committee is formed, they have to register it in the agricultural office. The requirements listed to form a WUA include the elaboration of the WUA’s bylaw, a legal document presented in the *woreda* court,[79] and the definition of rules and regulations on how to irrigate (e.g., on the scheduling and amount of water distribution); the type and frequency of members’ meetings; and the amount of fees for water services and monetary sanctions. These bylaws are based on a template provided by the agricultural office; however, WUAs decide on the specifics concerning their operations, for example, fee amounts, water turns, creation of farmers’ cluster for water distribution, and sanctions for non-compliance with the rules. This partial top-down approach has been recognised as a

[78] Agricultural officer lowlands (male) [E_Wa-ID-02] 27/01/2016.

[79] In practice, this document is a template provided by the government for all newly formed WUAs. Personal observations during fieldwork (in January-February 2016).

weakness to the self-governance of WUAs in Tigray, thus, affecting managerial autonomy and sense of ownership (Yami, 2016).

In Wargba *kebele*, irrigation groundwater is supplied by four deep wells; each one managed by a WUA (see Table 4.19). Surveys for this research were conducted in Alem Wargba and Lemlem Wargba WUAs.

Table 4.19 Water Users' Associations of Wargba *kebele*

Name of WUA	Water source	Ha	No. of water committee members			No. of HH members		
			Male	Female	Total	Male	Female	Total
Alem Wargba	Groundwater	36	60	16	**76**	129	116	**245**
Lemlem Wargba	Groundwater	30	27	31	**58**	95	94	**189**
Birham Adi Mokoni	Groundwater	36	85	13	**98**	83	69	**152**
Sharoit Wargba	Groundwater	36	39	19	**58**	83	89	**172**

Source: Irrigation Expert, Agricultural Office in Mohoni [E_Mh-Op-01] 25/01/2016.

In Kara Adishebo *kebele*, the number of WUAs indicated by the *woreda* agricultural office and the *kebele* agricultural office did not coincide. While in the *woreda* office the irrigation expert mentioned the existence of seven WUAs, in the *kebele* office information indicated only two WUAs were listed (see Table 4.20 below). Also, the number of members of the WUAs informed by those two offices was not consistent. Similar to other cases, information from the *kebele* appeared to be more up-to-date than that from the *woreda* office. Most of surveys and interviews were conducted in Ma'kadawa WUA and few in Anna WUA.

Table 4.20 Water Users' Associations of Kara Adishebo *kebele*

Name of WUA	Water source	Ha	No. of water committee members			No. of HH members		
			Male	Female	Total	Male	Female	Total
Ma'Akadawa	Groundwater	76	133	53	**186**	65	113	**178**
Anna	Groundwater	36	48	12	**60**	52	44	**96**

Source: Irrigation Expert, Agricultural Office in Mohoni [E_Mh-Op-01] 25/01/2016.

According to the *kebele* agricultural office head,[80] Ma'kadawa WUA owned three boreholes and 77 hectares of pressurised irrigation (sprinklers and drip irrigation). Pressurised irrigation systems were installed in 2006. Farmers were organised by irrigation clusters; each

80 Interview with Head of Agricultural Office Kara Adishebo *kebele* (male) [E_Ka-ID-01] 27/01/2016.

cluster had eight blocks of 0.25 hectare each. As mentioned earlier, as part of the WUAs' rules imposed by this *kebele*, farmers must purchase fertiliser in order to access water, plus they must pay monetary sanctions for not rotating their crops.[81]

In summary, the population of the highlands and lowlands of Raya Valley are overwhelmingly dependent on agriculture as a livelihood strategy. Soils are usually of good fertility and water sources are diverse and rather abundant. Irrigation is managed through a variety of formal and informal water users' organisations that at present count on a clearer and more transparent policy framework than there used to be in the past. While the formation of WUAs in the highlands is voluntary, access and use of groundwater in the lowlands, is only possible through formal WUAs. The majority of farmers keep a mixture of irrigated and rainfed farming plots. Small-scale farming relies on incomes from increasingly smaller farms. Many farmers keep some livestock, although in low numbers, usually as a safety net and/or for draft power. The low diversification of the livelihood alternatives observed among farmers using irrigation is an indication that farmers owning irrigated land are relatively better off than those in areas with only rainfed agriculture. In the described research sites, farmers using irrigation might be able to obtain between two to three harvests per year, contrasted with the one or maximum two that rainfed farmers may be able to produce; that is, providing that rainfalls are abundant. As indicated by participants in this study, farmers with irrigated land (even when owning small plots) were not considered to be poor (see Chapter 6 for more detail).

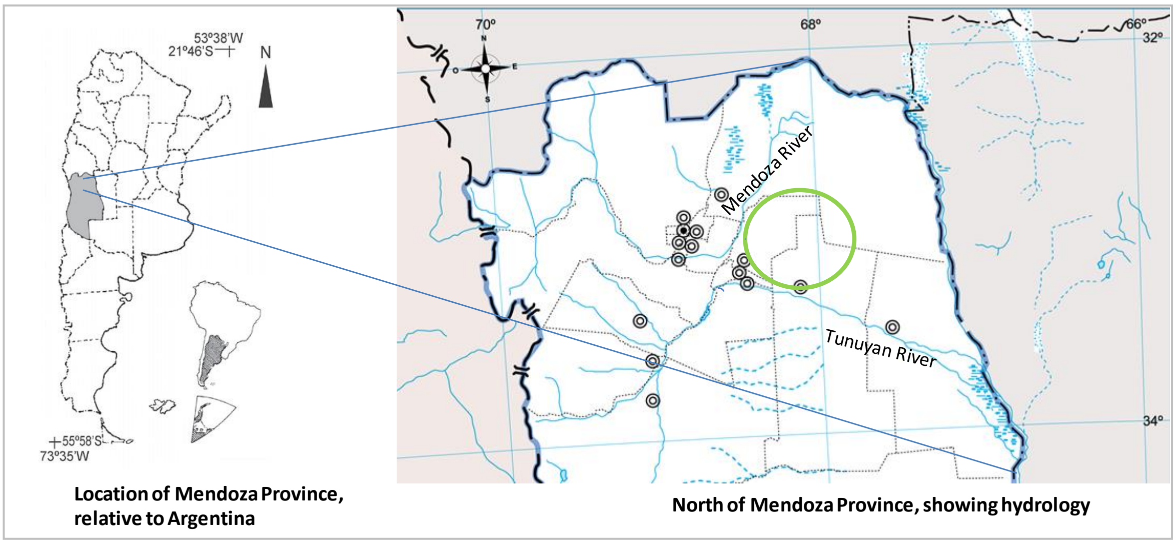
4.4. The study location Mendoza, Argentina

The Province of Mendoza, in central-west of Argentina, is an arid region that depends exclusively on irrigation for farming. Agriculture represents 7% of the GDP of the Province and is based on wine production (53%), fruit (25%) and vegetables (11%) (IDR, 2015b). Mendoza is composed of four hydrogeological basins: the Northern Basin (Mendoza and Lower Tunuyán Rivers), the Central Basin (Upper Tunuyán River), the South Basin (Diamante and Atuel Rivers), and the Malargüe irrigation zone in the southernmost part of the province. All the agricultural production of the province is concentrated in those areas, which occupy approximately 3% of the total territory. The other 97% contains scattered

[81] Interview with agricultural officer (female) [E_Ka-ID-02] 05/02/2016.

subsistence rainfed livestock productions, mining and oil extraction, mountainous areas and non-inhabited dried lands. The research sites selected for this study are located in the Northern Mendoza Basin (see Figure 4.12 below).

Figure 4.12 Location map of the study areas in Argentina.



Sources: Ministerio General de Escuelas (2015); Loyarte et al. (2009). Additions by author. Note: green circle represents the study locations in Mendoza.

The Northern Mendoza Basin occupies about 25% of the total province area and contains almost 80% of the population of the entire Province (see Table 4.21). Water resources are the backbone of the socio-economic development of this region in terms of household use, farming, agro-industries (particularly the wine production industry), a growing tourism sector related to rural and natural environments, and hydroelectric power production. In addition, some of the most acute problems affecting water resources in Mendoza are concentrated in this basin; namely, rapid urban growth over rural and natural areas, contamination of irrigation canals by solid waste (despite existing environmental regulations), and groundwater overdraft and salinisation in some eastern areas of the province (DGI, 2015; 2016).

Table 4.21 Main characteristics of the Mendoza River and the Lower Tunuyán River Basins

River	Total area	Water sources	Main socio-economic characteristics
Mendoza River	19,553 km^2	- Year-round water contributions from the sub-basins of high mountain rivers and streams - Seasonal contributions of the sub-basins downstream of the Mendoza River by concentration of rainfall from summer storms - Water flow regulated by the Potrerillos Dam - Intensive use of groundwater - DGI has established drilling groundwater restricted zones due to overdraft	- 65% of the population of Mendoza - Important urban growth over peri-urban and rural areas - Important farming areas oriented to high-quality wine production - Horticultural belt; supplier of fresh produce to a large urban population - Important industrial zones with 'incipient regulation and environmental control' of wastewater discharged (DGI, 2016) - Existence of agricultural areas irrigated by reuse of industrial discharged water - Important hydro-electric power production
Lower Tunuyán River	18,954 km^2	- Lower sub-basin of the Tunuyán River, downstream from El Carrizal Dam - Intensive use of groundwater (17,550 ha irrigated exclusively with groundwater). - Areas of drilling groundwater restriction due to low quality of first and second water tables	- 13.7% of the provincial population (DGI, 2015). Most of the area considered rural - 72% of the total agricultural area with vineyards. The rest, planted with olive trees, fruit trees and vegetables. Livestock activity has expanded in recent years in the eastern and northern parts of the basin - High concentration of wineries; many organised in wine cooperatives and a federation that dominates the provincial wine market - Existing problems of soils and groundwater contamination

Source: Author's elaboration with data from DGI (2015); (2016).

The characteristics presented in Table 4.21, highlight the complex environmental and socio-economic conditions under which water management institutions must operate.

4.4.1. Physical and climatic characterisation of the Northern Mendoza Basin

The topography of the study sites are dominated by lower plains with altitudes that range from 400 to 600 masl (DGI, 2016). The area corresponds to a large basin of fluvial and lacustrine deposits formed during the Tertiary and Quaternary Periods. Soils are mainly composed of alluvial deposits of diverse granulometry and contain intercalated deposits of gravel and sands, limes and clays. This defines well drained areas and impermeable patches (Torres and Zambrano, 2000). Typical from an arid area, soils are very poor in organic matter and usually alkaline (DGI, 2016). Salinity is frequently high in some areas, although agriculture is mostly viable through leaching (when drainage conditions are appropriate) (DGI, 2016).

The climate in both areas is typically arid with a monsoon precipitation pattern, and rainfall concentrated during summer months, especially in February. Average rainfall in the research locations is 224 mm in the Mendoza River Basin (DGI, 2016), and 250 mm in the Lower Tunuyán River Basin. More than 70% of the rainfall occurs from October to March (DGI, 2015). This insufficient precipitation determines the dependence of agriculture on irrigation. Maximum temperatures occur in January; in the Mendoza River Basin, the average annual temperature range is 31.8ºC (maximum) and 0.66 ºC (minimum) (DGI, 2014) and in the Lower Tunuyán River Basin, the average annual temperature range is 23.6ºC (maximum) and 8.2ºC (minimum) (DGI, 2015).

The entire basin is influenced by challenging climate conditions for agriculture with a stark impact on sector profitability. Two severe climate hazards, early season frost and hail, cause severe damage in the crop production of these areas. Early season frost has a generalised incidence in the region (DGI, 2016). Hail storms, typical of arid and semi-arid zones, are frequent between October and April, although the highest frequency occurs between late December and early January (DGI, 2015; 2016), coinciding with the active growing season of vegetables, wine grapes and harvest of stone fruits. Hailstorms are a localised phenomenon that may produce a loss of the entire seasonal crop production in a restricted number of farms. Another climate-related risk includes a local wind called 'Zonda' (Foehn effect);[82] particularly harmful during bloom as it dehydrates blossom, and is typically followed by low temperatures and frost. Argentina has national[83] and provincial agricultural emergency policy frameworks (DACC, 2017) that provide specific support to farmers who have partially or totally lost crop production due to climate hazards. Crop insurance is not yet established as a strategy for adapting to adverse climate conditions. Small-scale farmers, who produce within minimum profit levels, are usually the most affected producers in the province due to climate contingencies.

---

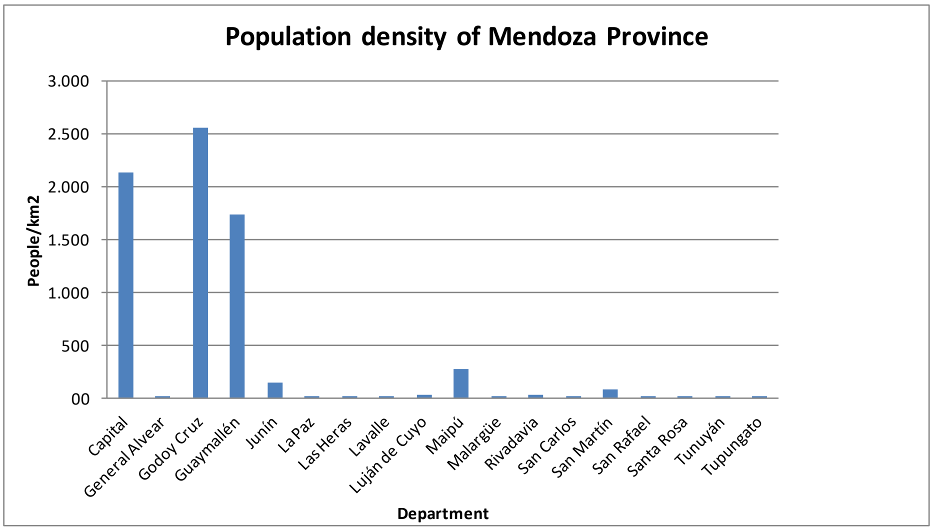
[82] The Foehn effect is produced by the passing of a humid wind from the Pacific Ocean over The Andes, discharging in the form of rain or snow, and then descending to the valleys as dry, warm and usually at high speeds (https://www.metoffice.gov.uk/learning/foehn-effect)

[83] Law Nº 26.509 (20/08/2009) (DACC, 2017).

4.4.2. Demography and social characterisation within the research sample

Mendoza is characterised by contrasting areas of high and very low population densities (see Figure 4.13). The last available population census (in 2010) indicates a total population for Mendoza Province of 1,738,929 (INDEC, 2019) inhabitants in a total area of almost 150,830 km^2 (Torres and Zambrano, 2000).

Figure 4.13 Population density of Mendoza Province by municipalities



Source: DACC (2014).

The municipalities of the Mendoza River Basin included in this study have a majority urban population (e.g., only 7% of the population of Guaymallén and 25% of Maipú is rural). This poses particularly challenging conditions for water resource management; in particular, hydraulic infrastructure maintenance and conflicts over productive soil and water use. In contrast, the municipalities of the Lower Tunuyán River Basin in the study have relatively larger proportions of rural population (e.g., in Junín, 47%; Rivadavia, 45%, and San Martín, 31%) (see Table 4.22 below).

Table 4.22 Area and population of the municipalities of the two river basins included in the study

Municipality	Total area (ha)			Population		
	Total	Urban	Rural	Total	Urban	Rural
Mendoza River Basin						
Guaymallén	16,400	6,400	10,000	283,803	264,413	19,390
Maipú	61,700	4,900	56,800	172,332	128,817	43,515
Lower Tunuyán River Basin						
San Martín	150,400	2,500	147,900	118,220	82,021	36,199
Junín	26,300	900	25,400	37,859	20,299	17,560
Rivadavia	214,100	1,300	212,800	56,373	31,038	25,335

Source: DEIE (2017) on data from INDEC (National Statistic Office), population census of 2010 updated in 2013 (INDEC, 2019).

The samples for the study in Mendoza comprised of farmers organised in WUAs (for surveys) and relevant key informants (for qualitative interviews). The survey sample was stratified according to perennial or annual crops (see Chapter 3 for details on sample selection). The survey participants (n=79) were 53% (n=42) men and 47% (n=37) women (see Table 4.23 below). The majority of respondents in both research sites were married. The average age of all respondents was 56 years old, showing a generalised aging of the farming population. Annual crop respondents appeared slightly younger than the perennial crop growers (see Table 4.24). This changing demography of the study areas is explained by a mixture of socio-cultural background and economic conditions of the sector.

Of the survey respondents, 96% of wine and fruit growers were of '*criollo*' origin (farmers born in Mendoza and being of European descent). *Criollo* farmers have usually been involved in farming activity all their lives and they inherited their land; however, the younger generation in these families rarely participate in farming. Youth, especially in rural areas close to cities, tend to migrate in search of better education and job opportunities. The remaining respondents were one migrant from the north of the country (*norteño*), and one from Bolivia. Of the respondents in annual crop productions, 62% were *criollos,* 20%, *norteños*, and 18% from Bolivia. *Norteños* and Bolivians acquired their land by saving income earned as farm labourers. They employ (unpaid) family labour, including youth, during peak seasons and their living costs are said to be generally lower than those of *criollos.* Accordingly, they can sustain families on smallholdings.

Table 4.23 Characterisation of survey respondents by gender – Mendoza

Characterisation of respondents	Male	Female
Average age total (n)	53.2 (42)	46.8 (37)
% Marital status (n)		
Married	83.3 (35)	83.8 (31)
Single	7.1 (3)	5.4 (2)
Widowed	2.4 (1)	5.4 (2)
Divorced	7.1 (3)	5.4 (2)
% Household type (n)		
Male headed household	81 (34)	43.7 (16)
Female headed household	0 (0)	17.1 (6)
Both heads of household	19 (8)	35.1 (13)
No answer	0 (0)	5.4 (2)
Average household size total (n)	3 (42)	4.7 (36)
% no answer (n)	0 (0)	1.3 (1)
% Education level (n)		
No education	0 (0)	0 (0)
Primary incomplete	19 (8)	29.7 (11)
Primary complete	33.3 (14)	45.9 (17)
Secondary	23.8 (10)	10.8 (4)
Technical/Vocational	7.1 (3)	0 (0)
Higher education	14.3 (6)	8.1 (3)
No answer	2.4 (1)	5.4 (2)
% Total respondents (n)	**100 (42)**	**100 (37)**

Source: Survey of farmers in Mendoza, July – December 2016; May – June, 2017.

Table 4.24 Average age of respondents by study site and gender- Mendoza

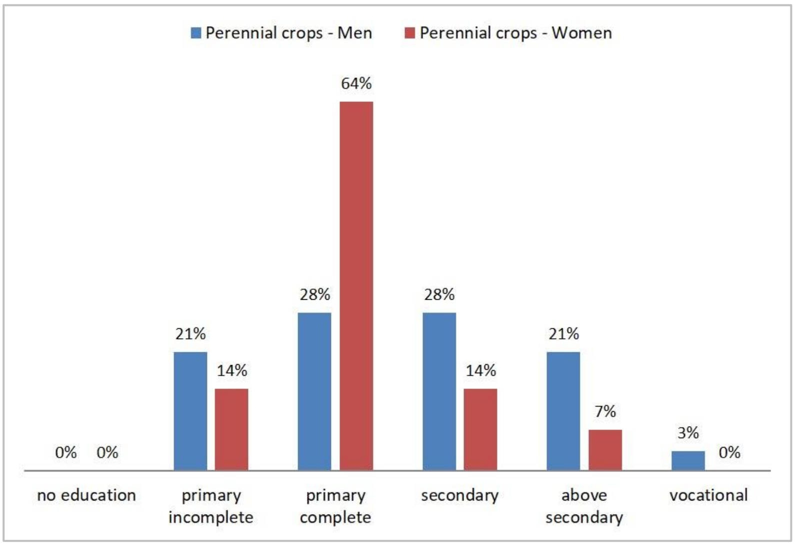
	Average age total (n)	Average age male (n)	Average age female (n)
Type of crop	**56 (78)**	**59 (42)**	**53 (36)**
Perennial crops	60 (44)	60 (30)	61 (14)
Annual crops	51 (34)	59 (12)	47 (22)

Source: Survey of farmers in Mendoza, July – December 2016; May – June, 2017.

The classification ‘male head of household’ or ‘female head of household’ was difficult to fit in the cases of interviewees in Mendoza when both husband and wife were present in the household. This typology was discussed in most of the interviews. In fact, in younger families, the use of this classification is in decline. Male or female heads of household as a formal classification is more commonly applied to households where women or men are sole occupants and/or one of them is the major income provider and decision maker. In spite of this, from all respondents, 63% (n=50) indicated that males were heads of household, 27% (n=21) said that it was a dual household (wife and husband sharing leadership), 8% (n=6) said a woman was the head of the household, and 3% (n=2) did not answer. This may be explained by the fact that older farmers and rural communities have traditionally considered the man as the head of the household.

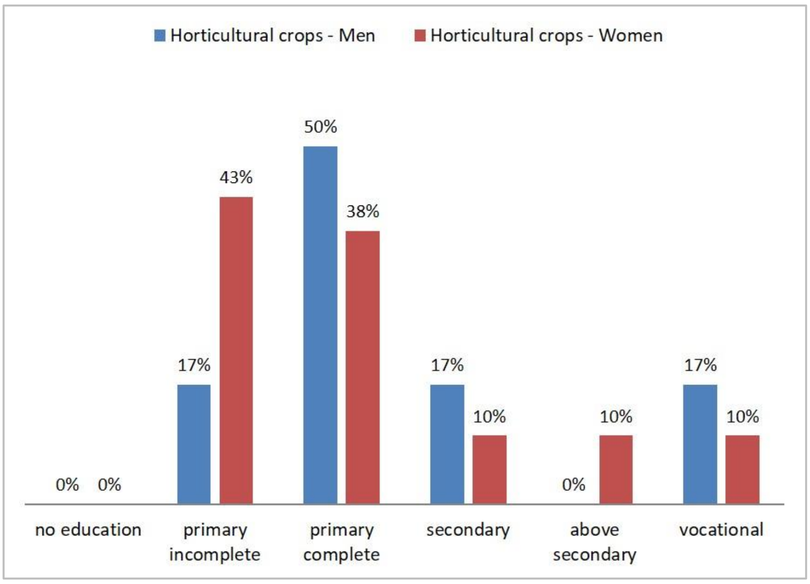
Literacy rates in rural areas of Mendoza reached 95.2% in 2016 (DEIE, 2016). Of the survey respondents, while more women than men had completed primary education, more men had access to secondary education than women (see Table 4.23 above). This trend was observed within the perennial crop growers (see Figure 4.14 below). Within the annual crop growers, women in general appeared to be less educated than men in primary and secondary education, except in incomplete primary education (see Figure 4.15 below). These results may be influenced by the socio-cultural composition of the sample within both types of cropping systems. According to the sample results, education levels of *criollo* farmers tended to be higher than for those from other socio-cultural backgrounds included in the sample.

Figure 4.14 Education level of respondents of perennial crops by gender



Source: Survey of farmers 2016-2017.

Figure 4.15 Education level of respondents of annual crops by gender



Source: Survey of farmers 2016-2017.

4.4.3. Livelihood characterisation of perennial and annual crop production areas in the Northern Mendoza Basin

Small-scale farming plays a key role in sustaining livelihoods in rural Mendoza. The structure of the farming sector is dominated by small and medium sized, mostly family-unit producers. According to the research design for this study, surveyed farmers were involved in small-scale farming production as the main economic occupation. This selection criterion, however, presented challenges in Mendoza because the current low profit-making nature of agriculture forces most farmers to supplement their income with additional occupations. All the men interviewed indicated that they were involved in farming, while 40.5% of women indicated that they were exclusively housewives (see Table 4.25 below). Other occupations mentioned were as an agricultural daily labourer (one man), a sharecropper, having permanent employment, and owning a business. From all respondents, 31.6% had already retired from some previous work activity.

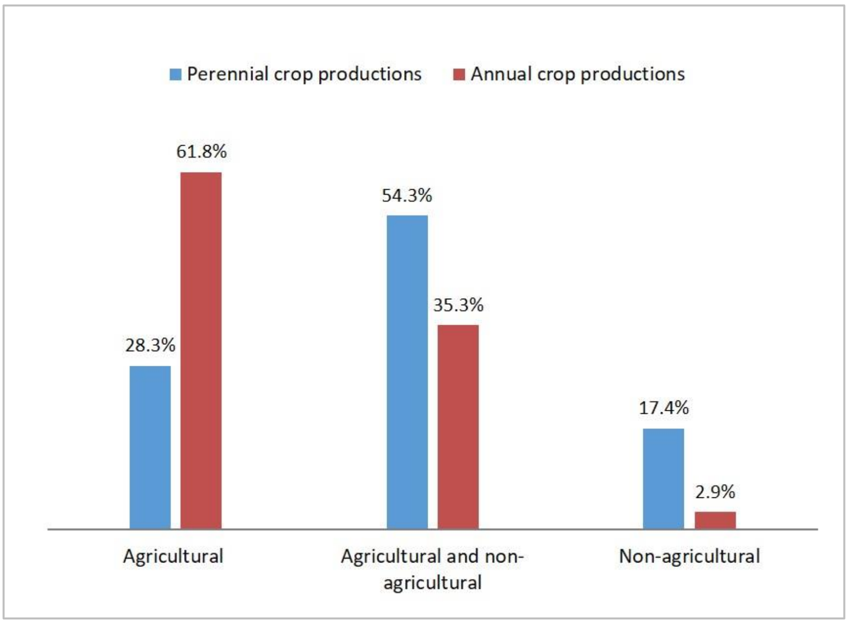
Table 4.25 Occupation of respondents in the lowlands study sites – Mendoza

Occupation	Percentage male (n)	Percentage female (n)
Farmer only	40.5 (17)	24.3 (9)[a]
Farmer + agricultural daily labour	2.4 (1)	0 (0)
Farmer + sharecropper	2.4 (1)	0 (0)
Farmer + permanent employment	19 (8)	8.1 (3)
Sharecropper	7.1 (3)	8.1 (3)
Farmer + agricultural own business	2.4 (1)	13.5 (5)[b]
Farmer + retired	26.2 (11)	5.4 (2)
Housewife exclusively	0 (0)	40.5 (15)
% Total respondents (n)	**100 (42)**	**100 (37)**

Source: Survey of farmers 2016-2017. Note: (a) Women indicated being farmers and house wives; (b) four of those women belonged to a government supported project for families to produce homemade wine.

In Mendoza, profitability of the small-scale farming systems appeared to be related to the amount of land cropped, which varied according to the cropping system, whether perennial or annual, and the farming techniques applied. Most of smallholders interviewed in Mendoza were managing their farms with a minimum of inputs; e.g., old or already obsolete farming tools and equipment, and increasingly, minimum maintenance work. For example, fruit trees and vineyards were not being pruned or weeded. As a result, an increasing number of farmers had to rely on non-agricultural incomes to make ends meet, most prominently the perennial crop growers (see Figure 4.16). Strikingly, more than 40% of the farmers surveyed were found to be dependent on self- or relative's retirement income in order to avoid selling their land (see Table 4.26). According to informants, it is more challenging for rural women to find appropriate off-farm job opportunities[84].

Figure 4.16 Type of income according to cropping system - Mendoza



Source: Survey of farmers 2016-2017.

Table 4.26 Incomes of perennial and annual crop growers surveyed – Mendoza

Type of income	Perennial crop production		Annual crop production	
	Primary income	Secondary income	Primary income	Secondary income
	Percentage of respondents (n)			
Agricultural production	35.6 (16)	40 (18)	70.6 (24)	35.3 (12)
Agricultural employment	6.7 (3)	2.2 (1)	5.9 (2)	2.9 (1)
Agricultural own business	2.2 (1)	2.2 (1)	2.9 (1)	2.9 (1)
Agricultural part-time labour			2.9 (1)	8.8 (3)
Livestock production			2.9 (1)	
Non-agricultural employment	11.1 (5)		2.9 (1)	
Non-agricultural own business	8.9 (4)	2.2 (1)	2.9 (1)	
Retirement	35.6 (16)	20 (9)	5.9 (2)	11.8 (4)
Family help/remittances		2.2 (1)		
Non-agricultural, rents			2.9 (2)	2.9 (1)
No other source		31.1 (14)		35.3 (12)
% Total respondents (n)	**100 (45)**	**100 (45)**	**100 (34)**	**100 (34)**

Source: Survey of farmers 2016-2017.

[84] FGD with female farmers and extension officers [A_Ts-G-01] 20/11/2016; FGD with female farmers [A_Ti-G-08] 23/05/2017 and [A_Ti-G-09] 31/05/2017.

4.4.4. Small-scale irrigated agriculture in Mendoza

Land tenure, land use and socio-cultural characterisation of farmers in Mendoza

Farming in Mendoza is concentrated in small and medium size plots (less than 10 hectares) as emerged in an analysis of the registries of the private agricultural water users of DGI (Imburgia, 2017) (see Table 4.27 below).

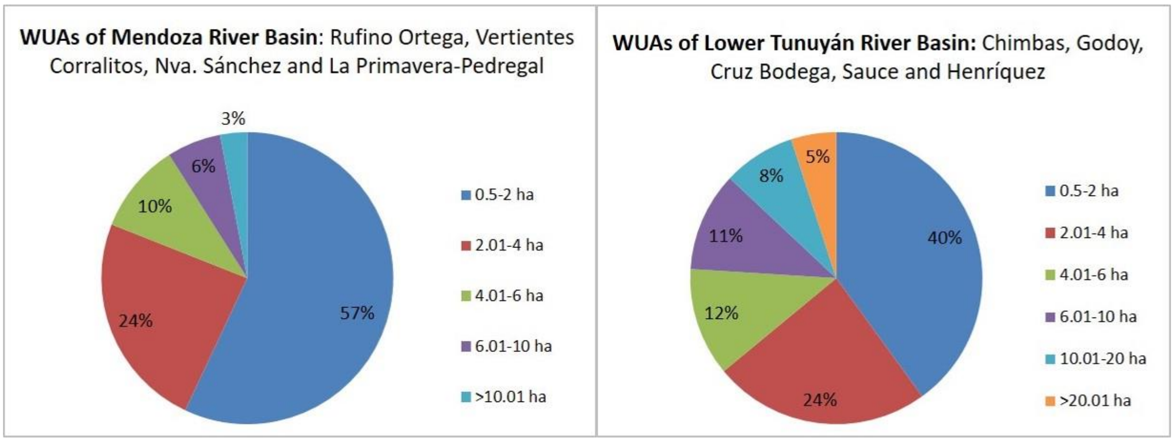
Table 4.27 Stratification of agricultural water users in the research locations according to land size

River basin	Total private irrigators (N° of registries)	**Percentage of private irrigators (agricultural use)** (including 6 bimonthly unpaid fees until 24/10/2016)					
		<0.5 ha	0.5-4 ha	4.01-10 ha	10.01-20 ha	20.01-40 ha	>40 ha
Mendoza River	**14,689**	**25.1**	**47.5**	**16.4**	**6.5**	**3.0**	**1.5**
Lower Tunuyán	**9,826**	**13.4**	**49.1**	**22.9**	**8.5**	**3.9**	**2.0**

Source: Data from Water Distribution List, DGI. Date accessed: 24/10/2016. Elaborated by author. Presented in Imburgia (2017).

Likewise, a similar irrigation stratification by land size was found when analysing registries of water rights holders belonging to the WUAs included in this study. The results in Figure 4.17, below, show that 97% of water rights holders in the WUAs of the Mendoza River Basin, and 87% of the water rights holders of the WUAs of the Lower Tunuyán River Basin, have farms of 10 hectares or less.

Figure 4.17 Irrigation stratification of the WUAs included in the study.



Source: Data from Water Distribution List, DGI. Date accessed: 24/10/2016. Elaborated by author. Presented in Imburgia (2017).

In recent years, the agricultural production sector of Mendoza has been severely affected by fluctuant political and economic conditions, unfavourable exchange rates, very high levels of inflation, and agricultural policies offering limited support to the sector (Montaña and Fernández, 2010).[85] This complex context, in addition to adverse weather conditions,[86] has determined a severe profitability crisis in the sector that has particularly affected the small and medium scale farming sector (Saieg, 2017; Montes de Oca, 2018). In the last decade, the costs of inputs grew exponentially, while market prices have been very low for farmers. As a consequence, there has been a growing process of land abandonment and/or a shift to non-farming uses of rural soil. This affects important areas of the Province, markedly the Northern Mendoza Basin (DGI, 2015; 2016).

In the agricultural sector of the study areas, land tenure is mostly based on privately-owned farms (more than 80% of the properties) and the majority are managed by the farm owners (Severino, 2008). To enable farm productivity of small-scale farming (i.e., 0.5 to 10 ha), most small-scale farmers apply traditional agronomical practices with low rates of innovation and investments. These are farmers with limited access to technical agricultural support provided by government extension programmes. More frequently, farmers receive ad hoc technical assistance from private input vendors. Moreover, agricultural research in the province is, in general, poorly disseminated (Severino, 2008).

Results from the fieldwork indicated that the majority of the surveyed respondents (86%) were owners of their land, followed by sharecroppers (9%), land tenants (4%), and both landowners and sharecroppers (1%). Of the perennial crop growers surveyed (see Table 4.28), 95.5% were landowners; and of the annual crop growers surveyed (Table 4.29), 79.4% were landowners. The average land size of respondents producing perennial crops was 11.24 hectares (n=42) and of respondents producing annual crops was 4.34 hectares.

---

[85] In addition to consultation of local and national press, most interviewed informants also referred to the described challenges for the agricultural sector of Mendoza, for example: Deputy Coordinator DGI (male) [A_M-ID-01] 18/04/2016; manager of 2nd grade WUAs Mendoza River Basin (male) [A_3aM-ID-05] 28/07/2016; DGI Delegate (male) [A_At-ID-22] 17/10/2016.

[86] El Niño in 2015-2016 generated intense rainfall with very unfavourable timing for agriculture in Mendoza, e.g., during the harvest of vegetables, or fruit maturation and the harvest in vineyards that resulted in the development of plant diseases.

Table 4.28 Summary of land property by household type of the survey participants of perennial crops in Mendoza

Crop system	Socio-cultural group	Land tenure	HH type
Perennial horticulture (n=45)	43 '*criollos*' (96%)	39 landowners	24 male heads of HH
			3 female headed HH
			12 dual HH
		1 landowner + sharecropper	1 male headed HH
		3 sharecroppers	3 male headed HH
	1 '*norteño*' (2%)	1 landowner	1 male head of HH
	1 migrant from Bolivia (2%)	1 landowner	1 male head of HH

Source: Survey of farmers 2016-2017.

Table 4.29 Summary of land property by household type of the survey participants of annual crops in Mendoza

Crop system	Socio-cultural group	Land tenure	HH type
Annual horticulture (n=34)	21'*criollos*' (62%)[87]	20 landowners	10 male headed HH
			1 female headed HH
			9 dual HH
		1 sharecropper	1 male headed HH
	7 '*norteño*' (20%)	4 landowners	2 male heads of HH
			2 female headed HH
		1 leases the land	1 female headed HH
		2 sharecroppers	2 male headed HH
	6 migrants from Bolivia (18%)	3 landowners	3 male headed HH
		2 lease the land	1 male headed HH 1 no answer (n/a)
		1 sharecropper	1 male headed HH

Source: Survey of farmers 2016-2017.

In the perennial horticultural crop areas, the sharecropper is locally called a '*contratista*': this tenant farmer (and their family) is provided with living space, credit for inputs, farming tools and machinery. In all responses in this study, bar one, sharecroppers of perennial crops were men; in that one case, a widow kept up her husband's contract after he passed away. The sharecropper works the land usually with his (or her) family. This relationship used to be informal, however, it has been legalised in the last decade. The new legislation establishes that farming tenants receive a salary, plus 18% of the net profit (InfoLeg, 2017).

[87] Two respondents were '*criollos*' but '*norteño*' in origen - born locally but parents from northern Argentina.

In the annual horticultural crop areas, the sharecropper is locally called '*chacarero'*: this tenant has a contract with the landowner for a salary plus a variable percentage of the production, which may be up to 50%. Additionally, living space may or may not be provided. Informal arrangements seem to be more common within annual vegetable growers. This may respond to the degree of formal organisation of markets. The wine sector is strongly regulated with clear product quality and safety requirements; mainly driven by the high quality and export market. In contrast, the vegetable production sector is more informal and much less regulated.

Land tenure by gender

In Mendoza, similar to Ethiopia, there is a gender gap in land tenure. An analysis of the registered names of 2,123 land titles corresponding to agricultural water rights of the nine WUA studied in Mendoza, indicated that an average of 31% of the titles were registered in the name of women and an average of 69% in the name of men (see Table 4.30 below). Results from the survey clarified that only 22% of the farms with land titles were in women's names alone, with 9% as dual titles; i.e., both a male and female member of the family owning the land (see Table 4.31). The gender gap in land ownership by women is a persistent concern in most developing countries (Lastarria-Cornhiel et al., 2014; Meinzen-Dick et al., 2017).

Table 4.30 Percentage of land ownership by gender of registered landowner with irrigation water rights, according to DGI -Mendoza

Gender	Percentage of land ownership from WUAs in the research locations								
	Rufino Ortega	Vertientes Corralitos	La Primavera	Nueva Sanchez	Carril Chimbas	Cruz Bodega	Henriquez	Godoy	Sauce
Male	70.37	65.8	68.32	69.0	71.9	67.0	71.7	69.5	66.1
Female	29.63	34.2	31.68	31.0	28.1	33.0	28.3	30.5	33.9

Source: DGI Distribution list up to 24/10/2016 (DGI, 2016). Elaborated by author.

Table 4.31 Gender of the land title holder – Mendoza

Gender of the land title holder	**Percentage of respondent (n)**
Land title in male's name	70 (48)
Land title in female' name	22 (15)
Dual (male and female name on the land title)	9 (6)
% Total respondents with land titles (n)	**100 (69)**
No land title	(7)
No answer	(3)
Total respondents of survey (n)	**(79)**

Source: Survey of farmers 2016-2017.

Crop production

Agriculture represents 7% of the GDP of the Province and it is based on wine production (53%), fruit (25%) and vegetables (11%) (IDR, 2015a). The annual horticulture production (vegetables for the fresh market and for processing) is concentrated in peri-urban and rural areas near larger urban centres.[88] A substantial part of the vegetable supply is produced by family landholdings of small and medium size.

Within the survey, plots in the perennial horticulture study areas were commonly dominated by one crop, mostly wine grapes (74%) and olives, peaches and plums. In the vegetable areas, farmers rotated several crops per season, notably tomatoes, leafy vegetables, garlic and onions (see Table 4.32).

Table 4.32 Percentage of surveyed farmers indicating irrigated crops planted (perennial crops) or included in their annual crop rotations (annual crops)

Perennial crops	**%**	**Annual crops**	**%**
Wine	74	Tomatoes	44
Olives	41	Leafy vegetables*	44
Peaches	30	Garlic	32
Plums	30	Onions	18
		Pumpkin	18
		Potatoes	15
		Lettuce	12
		Maize	6
		Forage	6
		Sweet potatoes	3

Source: Survey of farmers 2016-2017.
Note: the percentages correspond to the proportion of farmers found using these crops from all the respondents; (*) for salads.

Results from Table 4.32 suggest that climate and market contingencies pose higher risks to the viability of perennial crop farms than annual crop farms, due to the concentration of production in mostly one crop. This concurs with results indicating that perennial growers were more involved in complementary income activities than annual crop growers, as discussed in section 4.4.3.

88 47% of the annual horticulture of Mendoza is concentrated in the northern Mendoza Basin, followed by 41% in the Valle de Uco (central Mendoza) and 6% in the south of the Province (IDR, 2015).

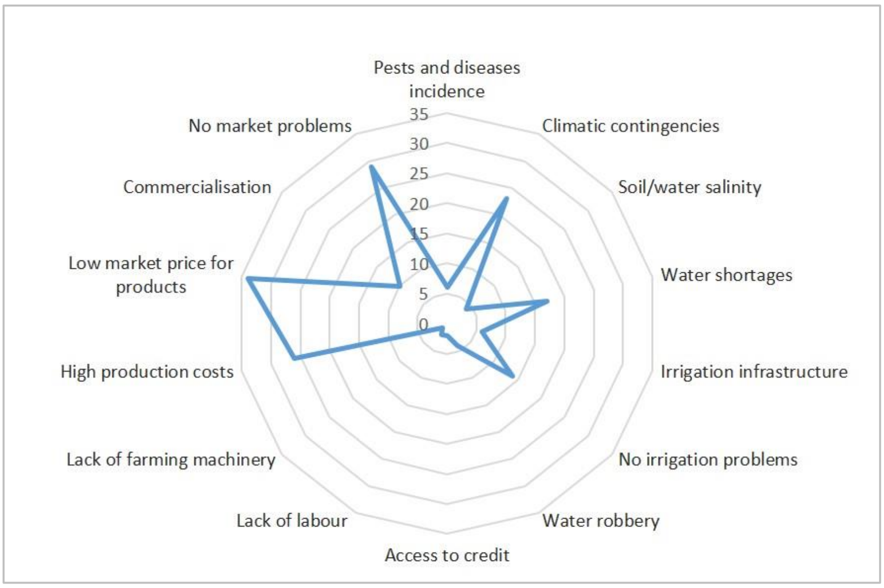
Constraints for perennial and annual crop production in Mendoza

In the last three decades, the wine sector of Mendoza has specialised in high quality, differentiated productions, especially oriented toward the export market. A significant part of small and medium sized grape wine producers have not been brought up to speed, in order to convert their vineyards to meet the current technical and market needs. This has left many farmers in precarious situations as they try to maintain their farms. Others have left the sector to search for job opportunities in urban areas (Brignardello, 2015). The fruit production sector has also been seriously affected, resulting in the abandonment of many orchards, plus the closure of a high number of processing firms and cold storage service providers. This has precipitated into a sharp reduction in fruit exports in the last decade. For example, between 2011 and 2017 the number of apple and pear growers dropped from 450 to 100, while the number of packing companies dropped from 34 to 7 (Saieg, 2017).

The vegetable crop sector is also constrained by severe profit and production challenges. The profitability margins are very unstable and hard to measure due to the production seasonality, fluctuating prices, and high incidences of adverse climatic conditions. In Mendoza, this sector operates with high informal conditions with regard to labour contracts, commercial agreements, and land tenure rights (SAF, 2015). In addition, the specific irrigation requirements of vegetable production (shorter intervals and less amount of water per turn than perennial crops) determine that the use of groundwater, exclusively or complementary, is of critical importance for profitable production.

In order to contextualise their water access and participation within irrigation systems, farmers surveyed were asked about the major constraints in irrigated farming in Mendoza. Their responses and frequencies are presented in Figure 4.18 below. To complete the range of factors affecting small-scale farming, survey responses were complemented with opinions from FGDs and in-depth interviews with informants (see Table 4.33 below).

Figure 4.18 Constraints in small-scale irrigated farming in Mendoza



Source: Survey of farmers 2016-2017. Frequencies calculated according to number of responses from surveyed farmers. N=55.

For most farmers, the greatest indicated constraint to farming was the discrepancy between the very high production costs and the low prices paid for agricultural products, especially when followed by harvest losses due to harsh climate conditions. Perennial growers who depended on only one crop and harvest per year appeared to have poorer profit margins than annual crop growers, who could rely on a variety of products grown in different seasons. For those farmers who needed to use groundwater to supplement surface water for their crops, water shortages determined how much land per season they were able to cultivate. In some cases, this is an exclusionary factor for impoverished small-scale producers who can neither afford to drill a deep well nor to pay for the electricity costs and water service fees[89] (an analysis of these factors will be discussed in Chapters 6 and 7).

89 FGD with female agronomists [A_M-G-01] 17/05/2017.

Table 4.33 Illustrative cases of key farming constraints in Mendoza indicated by informants in FGD and individual in-depth interviews, and thematically identified during the analysis

Key farming constraints identified	Illustrative cases
Due to low profit margins, small-scale farmers face difficulties to do maintenance work in their farms.	'There is abandonment of farms or part of farms. Some [smallholders] leave part of the farm unattended to invest only in part of it.' [FGD female agronomists, A_M-G-01, 17/05/2017]. 'Years ago, after selling my tomatoes in the farmer's market I used to stop by [the agrochemical vendor] and buy 20 bags of fertiliser. Today, I can only buy one or two'. [FGD male farmers, A_3aM-G-01, 30/08/2016].
Most farmers need to diversify their pool of agricultural income to maintain the economic viability of farming.	'Those who only have the vineyard are 'dead'. The level of profit in this area has been maintained because farmers produce several [vegetable] crops per season.' [Manager of 2nd grade WUA, Mendoza River (male), A_3aM-ID-05, 28/07/2016].
Qualified rural labour availability has become increasingly difficult to find.	'Nowadays nobody wants to work as farm labour. Only outsider come here to work [from Bolivia or northern Argentina].' [FGD female farmers, Lower Tunuyán River, A_Ti-G-09, 31/05/2017]. 'There is a lack of people who know how to prune or how to irrigate.' [FGD female agronomists, A_M-G-01, 17/05/2017].
Changes in soil use impose severe problems for irrigation water distribution.	'This area has changed a lot; 50 years ago, these were all farms. Today there are many new houses and condominiums. People throw garbage into the [irrigation] canals.' [FGD male farmers, Mendoza River, A_3aM-G-01, 30/08/2016]. 'There are many abandoned farms and their owners don't clean their part of the field channels. Then water is blocked'. [WUA leader (male), A_3aM-ID-07, 08/08/2016]
The difficulties that smallholders face to access credit prevent them from improving and diversifying.	'As small-scale businesses we have the most problematic situation. We cannot afford the cost of bank loans, we don't get subsidies [government social support to poor people] and taxes are too high'. [FGD female farmers Upper Tunuyán River, A_Ts-G-05, 25/10/2016] 'Many farmers here cannot access credit because they don't have the land titles in their names. Many haven't finished the succession process and the bank doesn't accept it as collateral.' [Coordinator WUAs DGI (male), A_M-ID-13, 09/08/2016].

Source: In-depth interviews and FGD in Mendoza, 2016-2017.

Livestock production

Although livestock production is relatively small in Mendoza, it is an important resource in some areas of the Lower Tunuyán River Basin (see Table 4.34 below), where 65% is produced in rainfed rangelands, and 35% under irrigation (DGI, 2015).

Table 4.34 Livestock production in the Lower Tunuyán River Basin

	Nº of animals per species (2008)						
Department	**Cattle**	**Sheep**	**Goats**	**Pork**	**Horses**	**Honeybees**	**Poultry**
Lower Tunuyán Basin	60,582	607	18,393	1,238	2,416	1,519	745,679
Total Mendoza Province	407,194	83,498	657,788	12,869	46,490	10,443	2,538,294

Source: DGI (2015) based on data from National Agriculture and Livestock Census INDEC 2008.

Of the survey respondents, very few engaged in livestock production. Only two respondents had medium-sized commercial poultry production for eggs and meat; eight respondents had chickens for household use; three respondents produced pork for domestic consumption, and 11 respondents had one horse, mostly used for ploughing in vegetable production.

4.4.5. Water resources in Mendoza

The hydrology of Mendoza Province is based on rivers fed primarily by snowmelt and rainfall runoff from The Andes (Hurlbert and Montana, 2015), which is then distributed through a network of hydraulic infrastructure towards the lowlands of the Province.

Land and water in the northern Mendoza Basin are predominantly used for agriculture. In the Mendoza River Basin, 74% of land registered by the DGI corresponds to agricultural use, and the remaining 26% is dedicated to other uses; i.e., potable water, recreation, industry, and power production (DGI, 2016). In the Lower Tunuyán River Basin, 63% of the registered land is classified under agricultural use, and the remaining 37% is dedicated to other uses (DGI, 2015). Therefore, farmers have a critically important role in the managerial and financial viability of the provincial water management system. This issue will be the focus of the analysis in Chapter 7.

Drinking water

The drinking water sector of Mendoza is managed by a private entity for drinking water and sanitation called *Aguas Mendocinas.* Potable water distribution is in turn managed at the municipal and sub-district levels. In addition, rural community organisations may be formed to collect fees and to pay for the construction of a piped water line to supply their areas. Monthly fees are variable according to the different locations and it consists of a fixed amount of money regardless of the volume of water used.

Of the study respondents, 85% (n=67) indicated having potable water on their farms and 15% (n=12) did not have any. In the annual crop areas, drinking water coverage was slightly less than in the perennial crop areas (see Table 4.35 below). On average, farmers from this study were paying a monthly flat rate of about 200 Argentine pesos (£10.80)[90]. Availability of water in households is an important difference compared to the case of Tigray; most farmers in rural Mendoza do not need to fetch water for domestic use. This, considerably, saves time and effort for the household members.

Table 4.35 Percentage of surveyed farmers indicating having potable water in their farms

Drinking water source	Perennial crop areas	Annual crop areas
	Percentage of respondents (n)	
Not available in the farm	9 (4)	24 (8)
Available in the farm	91 (41)	76 (26)
- Piped supplied	*85.4 (35)*	*65.4 (17)*
- Spring	*2.4 (1)*	*7.7 (2)*
- Deep well	*12.2 (5)*	*26.9 (7)*

Source: Survey of farmers 2016-2017.

Irrigation water

The irrigation areas of the research sites in Mendoza receive water from two rivers: the Mendoza River and the Lower Tunuyán River (see Figure 4. 19 below).

Figure 4.19 Hydrology of the Mendoza River Lower Tunuyán River Basins

Source: Loyarte et al. (2009).

90 By October 2016, the exchange rate was 15.14 argentine peso/1 USD or 18.49 argentine peso /1 GBP (www.xe.com accessed on 12/02/2018).

The hydraulic infrastructure in Mendoza Province follows a typical layout of main (primary canal), branch (secondary canals), and distributary canals (tertiary canals) - up to field channels. About 85% of the conveyance and distribution systems in the Province consist of irrigation canals constructed in natural or compacted earth. This causes significant problems like infiltration and loss of irrigation water, as well as the growth of vegetation in banks, thus reducing water flow. In view of these problems, modernising the water distribution scheme, including the lining of canals, has been a management and budgetary priority for the provincial water resource administration in the last two decades.[91] The images below, in Figure 4.20, show typical earthen and lined canals of the Mendoza irrigation system.

Figure 4.20 Earthen secondary channel (left) and lined channel (right) in Mendoza

Source: Fieldwork in Mendoza, Lower Tunuyán River. September, 2016.

4.4.6. Irrigation governance systems in the study areas of Mendoza

In Mendoza, irrigation water use and distribution through a network of canals has a long history dating back to pre-Colombian times. The formalisation of the water management sector, including the establishment of a robust water rights framework and a self-governance system through WUAs was legislated in the Provincial Water Law of 1884, later ratified by the Province Constitution of 1916. As a federal state, water resource management in Argentina is in the jurisdiction of the provincial government. In Mendoza, the highest-level

[91] DGI General Director (male) [A_M-Op-04] 26/04/2016; DGI Deputy Coordinator (male) [A_M-ID-01; DGI Engineering Department Director (male) [A-M-ID-12] 08/08/2016.

institution for irrigation water is the Water Resource Department (*Departamento General de Irrigación* -DGI). This office is responsible for devising and executing provincial irrigation policies. The operational management of the irrigation system is further decentralised and organised in WUAs, denominated as *inspecciones de cauce*.

The majority of the irrigation schemes in the research locations use surface water supplemented by groundwater. Of the survey respondents, 66% in the perennial crop areas and 35% in the annual crop areas use irrigation surface water exclusively (see Table 4.36 below). Furrow and basin surface irrigation are the most common irrigation systems used in small and medium sized farms. These irrigation systems are highly inefficient in terms of the amount of water used as compared to the crop needs, with high amounts of water loss through percolation and evaporation due to the arid climate conditions of Mendoza (see Figures 4.21 and 4.22 for illustration).

Table 4.36 Irrigation water sources indicated by surveyed farmers in Mendoza

Irrigation water source	**Perennial crops**	**Annual crops**
	Percentage (n)	Percentage (n)
Surface water exclusively	66 (30)	35 (12)
Complement surface water with groundwater	44 (15)	56 (19)
Groundwater exclusively	0	9 (3)

Source: Survey of farmers, 2016-2017.

Figure 4.21 A furrow irrigation system in an annual horticulture area of Mendoza River Basin

Source: Fieldwork in Mendoza, Guaymallén. June 2017.

Figure 4.22 A basin surface irrigation system in a vineyard in Lower Tunuyán River Basin

Source: Fieldwork in Mendoza, San Martin, September 2016.

Water users' associations in Mendoza

In Mendoza, having formal water rights is a necessary but not sufficient condition to access water. A water right holder makes rights operational through membership of WUAs. The direct participation of water users in the irrigation water management of Mendoza is a process that has been in the process of consolidation over a century and has, at present, a robust policy framework.

The *inspección de cauce* (WUA) is a public, non-governmental body that has autonomy and the legal capacity to reinforce policy related to surface water rights systems. Issues related to groundwater, including granting licences, are operated directly by the DGI (Hurlbert and Montana, 2015). Within the irrigation management system of Mendoza, WUAs exist for the purposes of administration, use, control, conservation, and maintenance of secondary and tertiary canals (Gobierno de Mendoza, 1996). All landowners with a registered water right are compulsory members of the WUA from the irrigation service area, thus, the land area where the WUA operates.

By 2017, there were 142 WUAs in all river basins of Mendoza Province. Following the premise of the water resource decentralisation in the 1980s and 1990s (Garces-Restrepo et al., 2007), which included increasing efficiency through economies of scale, many WUAs (68%) decided to associate with second grade associations (see Table 4.37 below). Being associated with second grade organisations has produced mixed results for WUAs in terms of cost and management efficiency (Imburgia, 2017).

Table 4.37 WUAs and second grade association level

River Basin	N° of Associations	N° of WUAs	N° of WUAs associated
Mendoza River	7	52	46
Low Tunuyán River	4	26	19
Upper Tunuyán River	2	20	12
Diamante River	0	20	1
Atuel River	4	22	18
Irrigation zone of Malargüe	0	2	0
Total	**17**	**142**	**96**

Source: Data collected from to key informants at DGI, May – December 2016.

WUAs are led by a WUA leader (*inspector*) with the assistance of a directory of three to five members. All those positions are democratically elected by WUA members. Each WUA hires one or more water guards (locally called *tomero*). Primary data for this study was obtained from nine purposively selected WUAs (see Table 4.38 below). This selection allowed for the analysis of WUAs of different sizes and covering a broad range of environmental and managerial challenges, as will be discussed in Chapter 7.

Table 4.38 WUAs included in the study from Mendoza and Lower Tunuyán River Basins

River	WUA	Hectares of private agricultural water users*	No. of private agricultural water users (no duplicates)**	% women members	Gender of inspector
Mendoza River	Association: *Tercera Zona*				
	- Rufino Ortega	805	135	30	M
	- Canal Vertiente Corralitos Unif.	1,953	657	34	M
	- La Primavera-Pedregal	486	202	32	M
	- Nueva Sánchez	994	364	32	M
Lower Tunuyán River	Association: *Canal Independencia*				
	- Canal Matriz Chimbas	3,662	409	28	M
	- Cruz Bodega	890	103	33	M
	- Henriquez	450	46	28	M
	- Godoy	909	95	30	M
	- Sauce	1,875	112	34	M

Source: Data from water distribution list, DGI. Date accessed: 24/10/2016; elaborated by author.
Note: (*) With maximum of one year of water service fees unpaid; (**) Names of land owners having more than one plot registered were counted only once. Water users registered as private enterprises were not considered; (M) male.

In summary, water resource management is the fundamental survival strategy for the arid Province of Mendoza. Agricultural water use dominates the production use of water. Small-scale farms dominate the farming landscape of the Province, including the two areas of this study, the Mendoza and the Lower Tunuyán River Basins. Participants of the study were smallholders and landowners. In the perennial cropping systems, 96% of respondents were *criollos* (locally born and of European origin), while in the annual cropping systems 38% of respondents were migrants from the north of the country and from Bolivia. The irrigation water governance of Mendoza is supported by a robust policy framework that has been consolidated over a century using trial and error. The managerial and financial viability of the system relies on public, non-governmental WUAs that have evolved and adjusted to changing environmental, political, and economic conditions.

4.5. Chapter summary

This research project used a comparative, trans-regional design, which covered a high degree of diversity in terms of physical and socio-cultural contexts. The two countries selected, Ethiopia and Argentina, are characterised by contrasting natural resources, culture, socio-economic conditions, and production backgrounds. This chapter has provided context for these research locations.

Ethiopia is a low-income, agrarian country, which is densely populated – with almost 79% of the population being rural and dependent on agriculture as a predominant form of livelihood. Argentina is a middle-income country with only 7.7% of the population living in rural areas. In spite of this, the Province of Mendoza has a preponderant use of productive land for agriculture, and therefore, for water.

While Ethiopia has one of the lowest levels of human development in the world, Argentina is considered to be a country with high human development. Gender equality is still a matter of concern in both countries, however, more critically so in Ethiopia. Literacy is not yet universal in Ethiopia, with a still prevalent gender gap that affects women. In Argentina, above 97% of males and females are literate.

This chapter presented a characterisation of the resource systems, actors and water governance systems of the study locations within each country: Raya Valley, southern Tigray (Ethiopia) and northern Mendoza Basin, Mendoza (Argentina). This chapter has applied the elements of the conceptual framework that outline resource systems, actors and governance systems. In so doing, the chapter has discussed the specific physical, climatic, and demographic characteristics of the study localities. In addition, a livelihood characterisation of the research sites with descriptions of the survey respondents in terms of personal and household profiles, land use and production systems were included. For each country, an outline of water resources, irrigation systems and WUAs were also presented.

All the respondents from Tigray are small-scale landowners, most of them having lived in the area all their lives. Smallholders use traditional farming practices and have poor access to extension services. Participants in this study produce within very low margins of profit.

In Mendoza, the structure of the agricultural sector is dominated by small and medium sized producers. Productivity and profitability of the agricultural sector have been negatively impacted by economic and political factors, further exacerbating the negative effects of a prolonged drought that has affected the Province since 2005-2006. As a result, a large proportion of the agricultural water users (who form the backbone of the provincial water management system) are now operating under precarious conditions and serious threats to the sustainability of the entire provincial water management system.

Having contextualised the study regarding the geographical, socio-cultural, livelihood and irrigation water resources and governance systems, the next chapter presents the first academic paper with the new conceptual framework developed for the study, plus its application used as a gender-analytical approach.

5. Irrigation and equality: An integrative gender-analytical approach to water governance with examples from Ethiopia and Argentina

The content of this chapter has been published as Imburgia, L. (2019). Irrigation and equality: An integrative gender-analytical approach to water governance with examples from Ethiopia and Argentina. *Water Alternatives,* **12**(2) 571-587.

Abstract

This paper proposes the use of an integrative framework for better conceptualisation and operationalisation of research geared toward understanding irrigation systems, practices and processes, especially as relates to gender equality in water governance. More specifically, it discusses the importance of developing an integrative gender-analytical approach that enables both researchers and practitioners to analyse the complex interactions between technical and social dimensions of water governance, in order to determine how they contribute to, and thus effect, the overall success and sustainability of irrigated agriculture. Consequently, this paper provides a detailed account of the framework's key components; including how it is informed by feminist, ecological and sociological theories. There is also an account of the framework's practical application through a focus on specific outcomes in the dynamic field of water governance. To this end, the paper presents some results derived from an application of the integrative gender-analytical framework on data from a comparative study of small-scale irrigation systems in Ethiopia and Argentina. Ultimately, the goal of this paper is to promote a more nuanced and holistic approach to the study of water governance—one that takes both social and technical dimensions into similar account; particularly, if the aim is to promote broader social equality and the sustainability of irrigation systems.

Keywords: Small-scale irrigation, gender-analytical framework, water governance, social relations, Ethiopia, Argentina.

5.1. Introduction

Irrigation development is a critically important strategy to increase agricultural productivity, secure agricultural livelihoods, enhance food security and, overall, overcome rural poverty for a large number of smallholders in diverse parts of the world (Van Den Berg and Ruben, 2006; Namara et al., 2010; Gebrehiwot et al., 2015). The question of equality – regarding access to resources, participation in managerial decisions and benefit distribution - in connection with sustainability and long endurance of communal irrigation systems is an ongoing subject of study and debate (Baland and Platteau, 1999; Ostrom, 2011; Lecoutere, 2011; Senanayake et al., 2015; Oates et al., 2017). This is particularly relevant today as traditional, hierarchical, top-down water management institutions undergo transition processes towards more inclusive forms of participation (van Buuren et al., 2019). It is well documented that within small-scale irrigation systems (SSIS), women are significant users of irrigation water (Wallace and Coles, 2005; Bennett et al., 2008). And yet, globally, gender differences remain evident in participation in irrigation scheme management and representation of water users in local irrigation governance structures, where male leadership dominates (Zwarteveen et al., 2010; Yami, 2013). A multitude of issues related to gendered social relations of power converge here, including control of and access to water (and other resources), traditional roles in the division of labour, unequal education opportunities, differentiated benefit-sharing mechanisms and incentives structures, and uneven gender participation and representation (Zwarteveen, 2008; D'Exelle et al., 2012; Agarwal, 2018). In many places, women continue to be deprived of secure tenure rights to land, while access to agricultural water rights from common water sources is usually dependent upon such land entitlements (Meinzen-Dick, 2014). This is a persistent source of gender difference and inequality that hinders poverty alleviation efforts (Agarwal and Herring, 2013; Meinzen-Dick et al., 2017).

While conducting gender assessments is now a required standard practice in most internationally funded natural resource management (NRM) and agricultural development programmes, advances in gender equality in the irrigation sector are not always commensurate with the gaps identified. This seems to be at odds with the urgency of the problem (Lefore et al., 2017; Imburgia et al., unpublished manuscript-c). A thorough understanding of the dynamics of gender involvement in self-governed communal SSIS is fundamentally important to devise sound technical and policy interventions for equitable economic livelihood development and food security (Domènech, 2015; Theis et al., 2018). It is also a necessity in the analysis of complex interactions within and between the social and technical dimensions of irrigation agriculture. In the study of water governance and equity in irrigation systems, there are scholars who have robustly integrated diverse theoretical perspectives, including an analysis of power (Brisbois and de Loë, 2016) and intersectionality, as relates to water, gender and other social differences (for examples, Harris et al., 2015; Thompson, 2016). It is argued however, that these theoretical approaches are difficult to be used as operational tools (Hanson and Buechler, 2015).

On the other hand, researchers and development organisations have elaborated various operational methods to collect and analyse gender-sensitive and gender-responsive data. For example, the Irrigation Learning and Improvement Tool (GILIT) (Lefore et al., 2017) and the Gender Performance Indicator (Van Koppen, 2002), offer mechanisms for scoring gender performance in small-scale irrigation schemes and projects based on pre-established sets of premises. Further, the Women's Empowerment in Agriculture Index (WEAI) is used to measure women's empowerment in agriculture by scoring key agricultural themes, including production, productive resources, incomes, leadership and time allocation (Alkire et al., 2013). While these tools contribute useful ways to systematically collect data and structure analyses, their quantifications are insufficient to understand and characterise socio-cultural and subtle power relations, as well as underlying drivers of gender difference (Akter et al., 2017). In addition, their effective implementation can be onerous and time-consuming; especially when considering that development projects often only have very short time-frames available to conduct comprehensive gender and livelihood analyses.

From this premise, it becomes clear that there is the need for a comprehensive and theoretically robust framework that allows the capture of holistic views of the complex interactions inherent to the operation and governance of natural resources, including irrigation systems. This paper addresses this issue through the provision of an integrative conceptual framework that does not pose high operational challenges. More specifically, as a gender-analytical framework, it seeks to examine a key question: *what are the outcomes of the interactions of gender, social relations and irrigation practice within the context of collective water governance?* The range of processes that govern these interactions are relevant to provide a comprehensive and nuanced understanding of how NRM, including water management, is gendered.

The paper therefore offers the framework to be used for the identification of key NRM and social inequality problems that are gendered. It does so by first providing a review of existing analytical approaches; thus discussing key insights from the literature in order to develop a conceptual framework that is suitable for gender analysis. The framework is then used to design and interpret a study of self-governed communal SSIS of Ethiopia and Argentina. These examples illustrate gendered differences in the access, use and participation of different groups of irrigation water users. Reflections on the application and the usefulness of the framework, as well as policy and practical implications, are also presented. The paper therefore seeks to contribute to ways in which involvement of different groups of women and men in communal small-scale irrigation can be explored.

5.2. The integrative gender-analytical framework to water governance

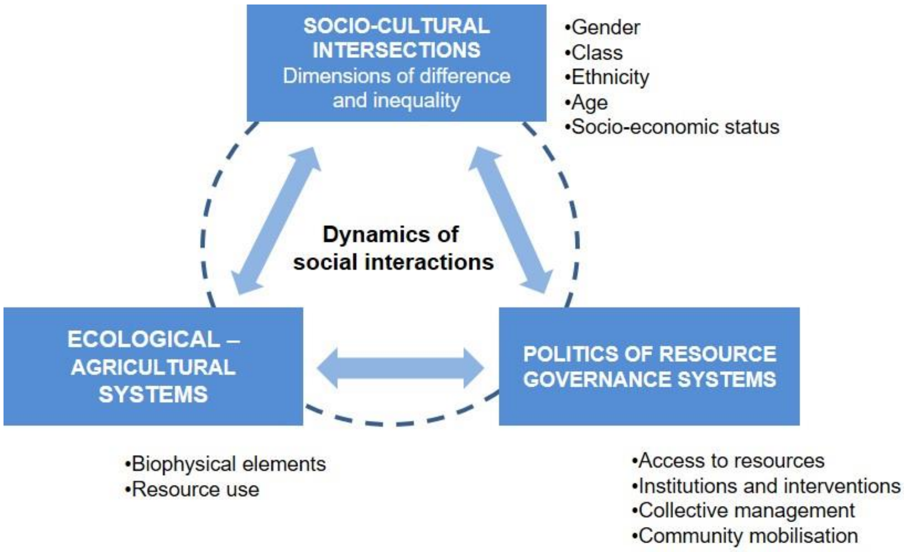
The conceptual framework proposed here aims to make visible two important aspects that have received only partial attention in the literature about women, gender and irrigation: (1) the intersections between technical properties of irrigation systems and practices derived from social interactions in collective irrigation water governance; in particular, gender roles and relations, and (2) the effects of those interactions in livelihood strategies. The framework is rooted in three theoretical concepts: feminist political ecology (FPE); social-ecological systems (SES) and social relations framework. These theoretical bodies offer useful analytical elements for the construction of the conceptual framework, as outlined below.

The FPE framework is useful to show how environmental policies and practices are influenced and defined by social, economic and political balances of power (Rocheleau et al., 1996). This framework understands all social relations as determinant variables, which explain local and global ecological, economic and development processes. It also assumes the existence of social differences and inequalities, in particular those related to gender (Rocheleau et al., 1996). Scholarship on FPE has been expanding at various levels as a need to theoretically contribute to current critical development and environmental matters (Harris, 2015c).[92] Applied to an irrigation system collectively managed by different users, an expanded FPE is conceptualised here as an interconnected arrangement of socio-cultural intersections, ecological-agricultural systems and governance arrangements. Figure 5.1 below shows selected elements of the expanded FPE, which have been utilised for the development of the gender-analytical framework as shown later as Figure 5.3.

---

[92] Thematic expansions useful for the current study include: the dimensions of difference that intersect gender with other social characteristics such as ethnicity, race, poverty, and "coloniality" (Harris, 2015: xx); the legal frameworks for property rights (Vaz-Jones, 2018); the increasingly complex environmental contexts of degradation, depletion of natural resources, and climate change (Harris, 2015); and the global socio-economic contexts such as massive migration movements (Momsen, 2017). There have also been thematic expansions that include multiple scales of analysis (Nightingale, 2015), issues of resource governance (Adams, Juran and Ajibade, 2018), and production systems based on the management of natural resources and agricultural systems (for example, Buechler, 2015).

Figure 5.1 An extended feminist political ecology (FPE) conceptual approach

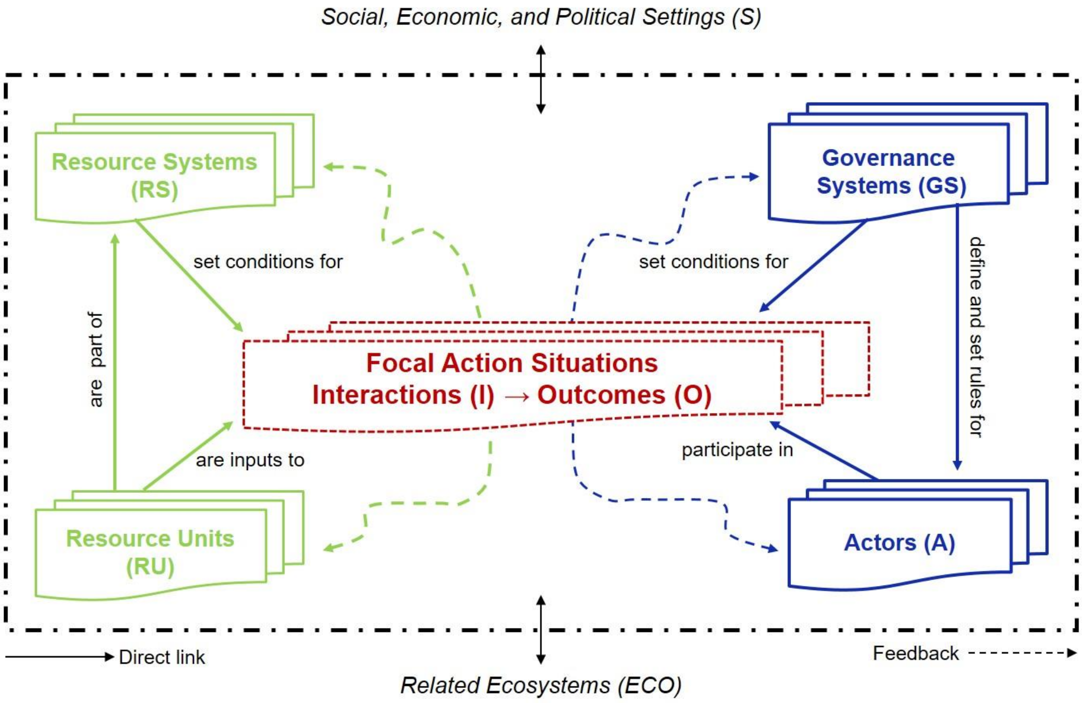


Source: Adapted by the author based on conceptual expansions of the FPE (Buechler and Hanson, 2015; Harris, 2015).

To introduce robustness to the 'ecology' dimension of the FPE framework, both conceptually (Najjar, 2015) and methodologically (Hanson and Buechler, 2015), the expanded FPE perspective is combined with the conceptualisation of a communal irrigation system as a social-ecological system (SES)[93]. Useful here is the definition of SES by Anderies et al. (2004: 6) as ‘the subset of social systems in which some of the interdependent relationships among humans are mediated through interacting biophysical and non-human biological units’, resulting in complex systems of multiple subsystems and larger systems. Building upon this reasoning, Ostrom (2007) proposes a ‘diagnostic method’ that reflects complexity by organising variables into tiers at different levels, which can be further unpacked into multiple conceptual tiers (McGinnis and Ostrom, 2014) as shown in Figure 5.2 below. Not all variables in a sub-system are relevant in analysing a given SES, and they function as ‘partially decomposable systems’ (McGinnis and Ostrom, 2014); this feature is particularly useful for the proposed gender-analytical framework as it allows sufficient flexibility to analyse particular aspects of any natural resource system.

[93] The linkage between FPE and SES frameworks is described as useful, by Buechler (2015), for examining interactions between activities performed by gender and ecological systems.

Figure 5.2 Revised SES framework with multiple first-tier components.



Source: McGinnis and Ostrom (2014), permission granted by the first author.

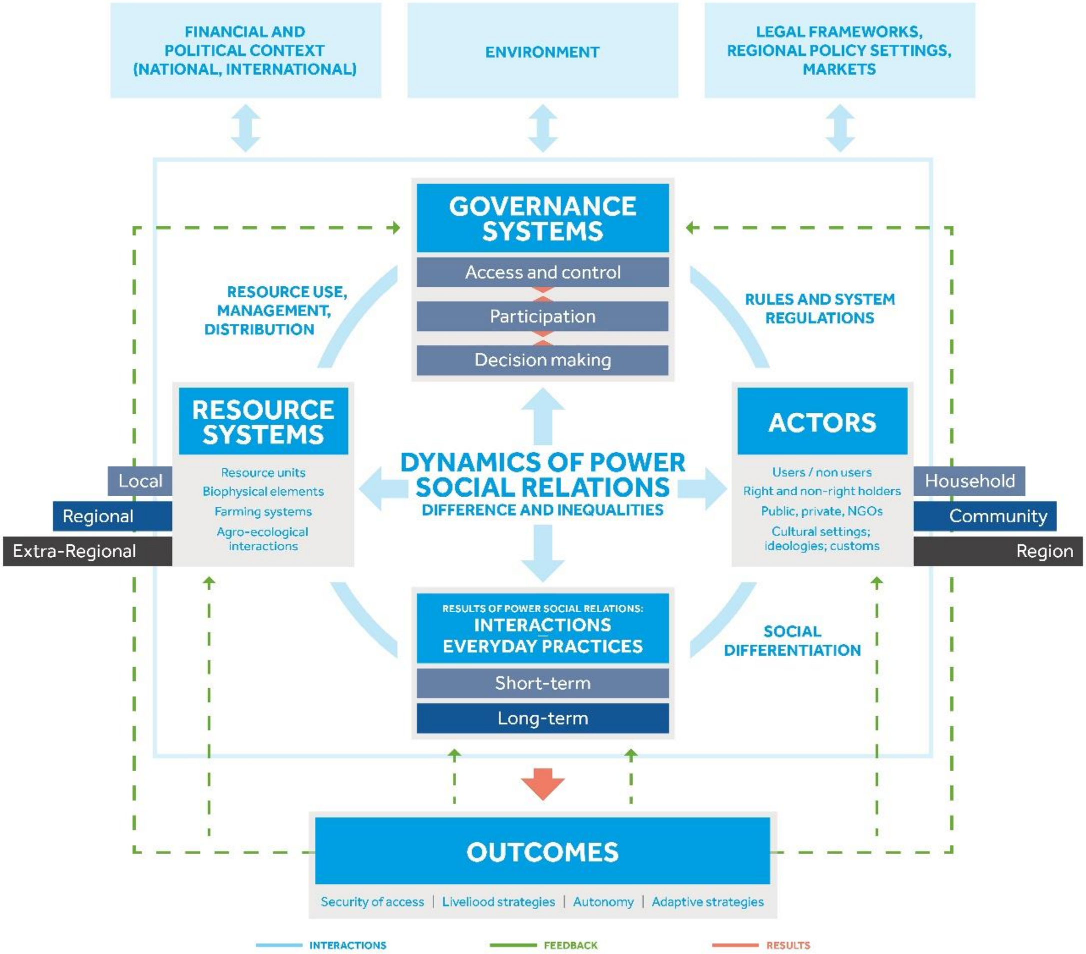
It is acknowledged that a comprehensive analysis of social relations of power appears to be missing within the Ostrom SES approach (Fabinyi et al., 2014); in particular, considerations of gender differences in the use and management of resource systems (Łapniewska, 2016). In order to address this limitation, three useful elements of the social relations framework (Kabeer, 1994; Kabeer and Subrahmanian, 1996) are drawn upon and connected to the combined expanded FPE and SES frameworks: (1) social relations between people, (2) relationships of people to resources and activities, and (3) configurations of those relationships and institutions. Thus social identities, roles, responsibilities, rights and control over one's self and others are understood as originating from social relations (March et al., 1999).

The notion that gender identities, roles and relations comprise what is known as 'socially constructed' and therefore not immutable has been widely adopted within gender and development scholarship. It is also a core concept of the gender-analytical framework proposed in this paper. Dynamics of gender relations are shaped, even modified by different factors including: access and control of resources and bargaining power (Agarwal, 1994;

Agarwal, 1997); constraints imposed by family relationships, commonly expressed as patriarchal models (Kabeer, 2011); balance of power and 'ability to exercise choice', i.e., agency (Kabeer, 1999); gender awareness (Kabeer and Subrahmanian, 1996); and development policies and their influence in modifying the balance of power between women and men (Momsen, 2010).

In many agricultural contexts today, common gender roles are changing and, in some places, quickly. The drivers of change are complex and context-specific. For example, in some places a 'feminisation' of agricultural activities is evident (Radel et al., 2012; Pattnaik et al., 2018) while in others, this process is less clear (Palacios-Lopez et al., 2015). Therefore, the development of an integrative gender analysis of NRM requires elements that broaden understandings of *who* accesses and uses the resources and *how*. This is done here by examining configurations of social relations of power as a core element of the conceptual framework filtering and/or catalysing the SES processes. By combining the above discussed elements of the expanded FPE, SES and social relations approaches, the gender-analytical framework for examining the dynamics of social relations driving the processes and outcomes of NRM governance is established and illustrated in Figure 5.3.

Figure 5.3 An integrative gender-analytical framework to natural resource governance.



Source: Developed by author.

In the application of the above conceptual framework, three key variables of resource governance are emphasised: access and control through property rights; participation in institutions of collective resource use, i.e., water users' associations (WUA), and decision-making regarding management practices. The resource systems (e.g. communal SSIS) are self-governed by diverse types of actors that include female and male farmers, who hold diverse land tenure rights. Other relevant actors are water- and agriculture-sector officials, and the private sector. These actors interrelate, producing certain dynamic social relations of power. In so doing, a number of overarching interactions emerge such as resource use, management and distribution; rules and system regulation; and social differentiation. These interactions materialise in everyday activities (Kabeer, 1994) related to the irrigation practice. In combination these elements produce governance outcomes that synthesise the core elements of the functioning of the irrigation governance system.

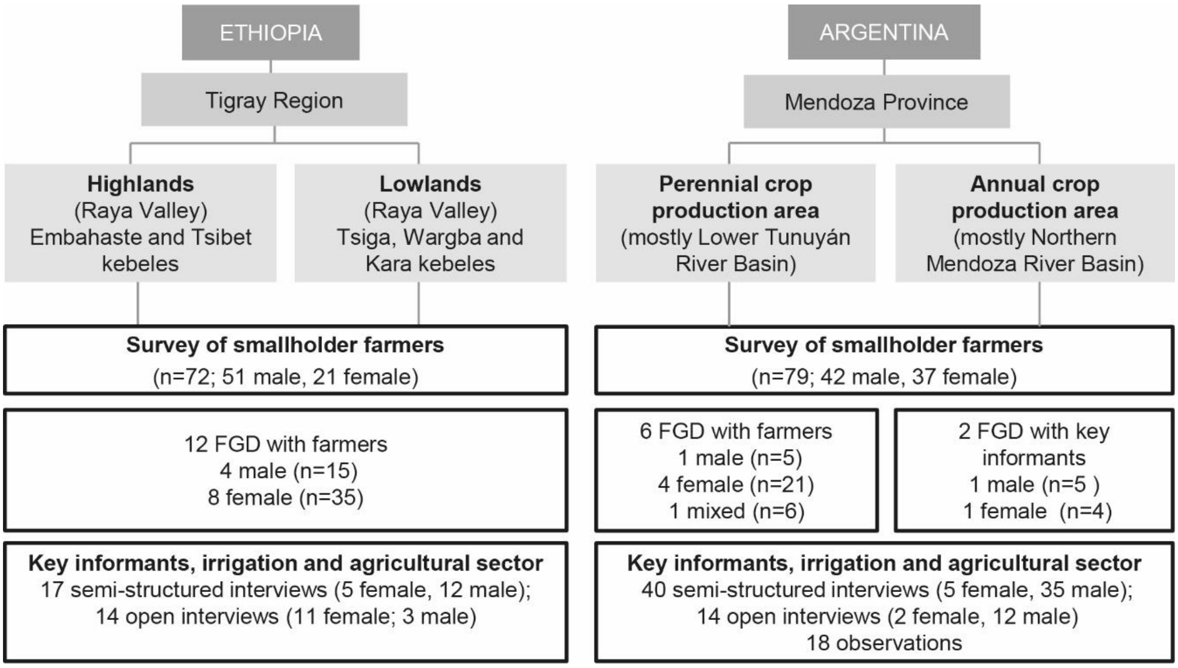
The remainder of this paper is a discussion on the application of the integrated gender-analytical framework to examine gendered outcomes of collective governance within small-scale irrigated agriculture in Ethiopia and Argentina. Focusing specifically on these outcomes (see the bottom of Figure 3) will help describe the most critical factors and mechanisms of women's and men's involvement in resource management. In order to contextualise the gendered governance outcomes, the next section will briefly describe resource systems, actors and governance systems.

5.3. Methodological approach

A high diversity of data was required to test this integrative gender-analytical framework. This diversity was pursued through two main approaches: first, designing a multicase study in two countries, and second, by using a mixed-method research approach. This research strategy proved useful in capturing a broad variety of aspects from two contrasting countries. It allowed for the systematic collection and analysis of both qualitative and quantitative data.

The data for the multi-case study was collected from southern Tigray (northern Ethiopia) and northern Mendoza (centre-west Argentina), during 2016-2018. The selected study sites offer a representation of diverse irrigation and cropping systems, as well as socio-cultural backgrounds. Data collection was undertaken in both locations using a mixed-method approach, which included a survey, in-depth interviews, focus group discussions (FGDs), and direct observations as shown in Figure 5.4.

Figure 5.4 Study locations in Tigray and Mendoza including sample size



Source: Developed by the author.[94]

A cross-sectional[95] stratified survey was used to obtain quantitative characterisations of the local resource systems, with a focus on the agricultural livelihoods of the SSIS studied. Participants of the survey were smallholder female and male farmers who used irrigation and were members of WUAs. In each country, the survey questions related to gender roles and distribution of labour in productive and domestic work, household livelihood structure, irrigation water access and management, and participation in WUAs – including their influence on gender equality.

In-depth interviews were conducted with a purposeful sample of female and male informants, including farmers, leaders of WUAs, central water agency officials, and irrigation and agricultural experts at district and local levels. The questionnaires focused on understanding the agricultural production and the irrigation governance systems of each research location. Questions regarding the differentiated roles of different groups of women and men in the irrigation sector were also included in all interviews. Additionally, semi-structured FGDs with purposively selected female and male farmers were used to obtain

---

94 *Kebele* is the Amharic word for sub-district.

95 Data was collected in one point in time.

views, experiences and ideas regarding everyday interactions and practices of actors in the selected SSIS. A background depicting age, marital status and socio-culture was pursued.

Data analysis was done through the coding and thematic analysis of qualitative data, and the utilisation of descriptive statistics. Thematic interconnections between qualitative and quantitative data were explored and synthesised into an analytical scheme. The resulting categories were related to the themes defined in the conceptual framework. The results informed all adjustments made to the framework.

5.4. Contextual characterisation of the study locations

In Tigray, the study was conducted in the Raya Valley, a semiarid area with an agriculture-dependent economy. In this region, 86.4% of households practise farming, and the large majority of these households are smallholders (WWDSE&CECE, 2014a). Rains follow a bi-modal pattern, and are usually scarce and erratic. The government is supporting the expansion of irrigated agriculture to improve food security (Gebrehiwot et al., 2015).[96] All respondents from the survey obtained income from irrigated crop sales. Livestock was also an important additional income source for people (as indicated by 83% of respondents in the highlands and 56% in the lowlands). Surveyed women and men were found to be growing similar crops, mostly cereals for household use with some surplus for the market in rain-fed plots, plus vegetables, cereals, pulses and fruits, mostly for the market in irrigated plots. All farmers interviewed utilised traditional low input agricultural practices to cultivate the farm plots.

In the highlands of Tigray, all irrigation is done with surface water distributed through communal earthen and lined channels, and furrow irrigation systems. In the lowlands, smallholders used groundwater lifted by electric pumps and distributed by furrows and pressurised irrigation systems (drip and sprinklers). All rights and responsibilities of access and use of irrigation water are by law, inherent to land rights and, thus, become operational

[96] By 2017, the total irrigated area of Tigray was 50,083 ha (based on data from the Tigray Regional Water Bureau) (Tewolde 2019). In the lowlands of Raya Valley, a regional governmental programme of irrigation modernisation has drilled deep wells and installed pressurised irrigation systems for smallholders. The programme includes the creation of WUAs, and management and cost transfer to farmers. Source: In-depth interviews to officials of the Regional Water Bureau, Mekele, February, 2016.

by participation in a WUA.[97] In the highlands, the formation of WUAs to collectively manage surface water is voluntary. Once an organisation is established, however, anybody who has land (that they wish to irrigate) in the WUA service area must become a member. The collective management of groundwater in the lowlands is performed by WUAs that have been established by the Water Office and participation is mandatory. Although in interviews with the regional Water Bureau it was mentioned that WUAs have a quota of women participating in water committees, this was not verified on the ground. In most WUAs interviewed (except one in the highlands), interviewees denied having to fulfil a gender quota for women.[98]

In Mendoza, the agriculture sector relies exclusively on irrigation due to the prevalent arid conditions. Data for this study were collected in irrigated farming areas of the Mendoza and Lower Tunuyán River Basins, where SSIS are important: an average of 62% of the farm land is occupied by family farms of up to 10 ha and an average of 48.3% of farms have less than 4 ha; farm sizes considered as medium and small scale, respectively, in the local context (Imburgia, 2017). In the perennial horticulture areas, plots are commonly dominated by one crop (mostly wine grapes) and stone fruits. In the annual horticultural areas, farmers rotate several vegetables per season. Recurrent economic and political crises in Argentina, with high inflation rates, huge cost increases and currency devaluation, undermine the profitability of the agriculture sector (Imburgia et al., unpublished manuscript-c).

Surface water and groundwater are both used for irrigation in the study localities of Mendoza. Most SSIS surveyed use furrow and flood irrigation. Interviews with key informants revealed that a large part of the existing irrigation schemes require modernisation of hydraulic structures and implementation of water conservation measures (e.g., water-saving irrigation practices, water reservoirs, and crop demand-led water distribution) in order to adapt to the severe and persistent drought of the last decade and to meet the growing

[97] Different types of WUAs were found in Tigray; i.e., formal irrigation WUAs registered in the Water Office, irrigation cooperatives registered in the Agricultural Office, and informal non-registered WUAs. A recent governmental Proclamation (nº 841/2014) provides detailed stipulations for the establishment of irrigation WUAs within the context of decentralisation and transfer of irrigation and drainage services to users (MWIE, 2014). The policy intends to amend the observed problematic governance of irrigation schemes due to the lack of differentiated roles of agricultural cooperatives and WUAs. Those problems were also reported by Yami (2013).

[98] The governmental Proclamation on irrigation WUAs (nº 841/2014) does not mention a female quota for WUAs (MWIE, 2014).

demand of competing (urban, rural and industrial) water uses. The central water administration of Mendoza does not have a gender equality framework in place.[99]

5.5. Outcomes of small-scale irrigation systems through an integrative gender perspective

In applying the proposed gender-analytical framework on communal SSIS in Ethiopia and Argentina, four key interrelated governance outcomes (shown in Figure 3) were identified: the functioning of the SSIS provided variable degrees of (1) security of access to water, which in turn conditioned (2) security of livelihood strategies and (3) the autonomy of individuals and communities to make informed decisions, lead resource management and solve collective-action problems. In addition, certain (4) adaptive strategies were used by farmers to protect their well-being or at the very least, their survival, especially from the variability and unpredictability of climatic patterns. For the purposes of this paper, this section presents the empirical evidence organised according to an analysis of those outcomes under a gender perspective, at both the household and local levels.[100]

Security of access

Data analysis of the two case studies indicates that the degree of security of access to irrigation water is conditioned by the legal framework in place, which impacts reliability and affordability of the resource. However, the capacity of farmers to actually use the irrigation water provided depends on factors that transcend the legal framework, the amount of water available, access to land and their gendered characteristics. A critically important factor is, for example, the physical ability of farmers to perform routine tasks of irrigation agriculture. As will be discussed below, technical properties of irrigation systems determine to a very large extent the corresponding physical work demand. Obviously, there are important gender differences in the ability to cope. Likewise, domestic workload, a well-recognised gender factor (Centrone et al., 2017) constrains the ability of female farmers to perform the work necessary to actually benefit from the availability of irrigation water.

---

[99] The central water agency of Mendoza does not request conducting gender analyses for any of their management activities, except for the implementation of projects of modernisation or expansion of the irrigation infrastructure funded by international credit institutions.

[100] Complementary fieldwork results and findings are presented in Imburgia et al. (manuscript unpublished-b; c).

In both countries, legal access to irrigation water is conditioned by access to land. All users with irrigated land rights are entitled to water rights from the corresponding communal irrigation schemes. This basic entitlement extends to the charter of WUAs with their rights and obligations. In Tigray and Mendoza, women in the survey had less independent land titles than men as was also found in farmer registries provided by WUAs.[101] In Tigray, of all interviewed farmers holding land certificates (n=62)[102], 22.6% were women as sole landowners, 59.7% were men as sole landowners and 12.9% were joint registrations, while rest at 4.8% did not know. Since the recent implementation of a land policy change in Ethiopia[103], more women are entitled to register land certificates in their own names (Holden and Tilahun, 2017). During data collection in 2016, these policy revisions had not been fully instituted in all of Tigray; however, by the 2018 data collection period there was substantial progress as an increased number of single and married women described having land certificates in their name.[104] In Mendoza, of the surveyed farmers owning land (n=69), 21.7% were women as sole landowners, 8.7% had jointly registered titles with their husbands and 69.6% were men as sole landowners. In Tigray, all of the women surveyed (except one), who had their own land entitlements, were also heads of households (93%).[105] In Mendoza, this was not the case - since only 20% of the interviewed women owning land belonged to female-headed households; whereas, 40% belonged to male-headed households and 40% to dual-headed households (wife and husband present).[106]

The prevailing gender difference in land tenure in Ethiopia and Argentina may be explained by both countries having land policies that enable women to independently acquire land;

---

[101] For detailed analysis of official registries, see Imburgia et al. (manuscript unpublished-c).

[102] The rest of farmers surveyed in Tigray leased land (2 farmers) and used a communal irrigated land, which use was granted by the *kebele* office. Source: Fieldwork in Tigray, 2016-2018.

[103] Traditionally in Ethiopia, land right certificates were commonly issued in the name of the head of the household, who tended to be male. In contrast, due to the Second Stage of Land Registration and Certification (SSLR) law, started in 2014, land acquired jointly by spouses can be registered jointly. At the same time, the law enables the addition of wives' names on older land certificates. In addition, young single women can register farming plots in their own names. This is land that they have inherited from their parents or else have received through government land distribution.

[104] Interview with Head of Agricultural office, lowlands [E_Mh-ID-01] 14/03/2018; FGD with married female farmers of the lowlands [E_Ka-G-04] 16/03/2018.

[105] Source: Survey of farmers in Tigray. January-February, 2016; March 2018.

[106] In rural Mendoza, the female/male-headship classification does not always match how families consider their intra-household roles. Whereas these categories are observed in elderly households and those of Bolivian origins, among younger families, a higher awareness of gender equality matters in terms of income generation and decision making. This renders this classification less useful. Source: Fieldwork in Mendoza, 2016-2017.

however, women are still constrained in exercising those rights due to prevalent structural inequalities such as lack of own capital, their lower societal status, and other socio-cultural restrictions (Imburgia et al., unpublished manuscript-c). Similar findings were noted in previous studies in Ethiopia (Berhane and Miruts, 2015; Dokken, 2015). In Mendoza, where the private property inheritance regime is egalitarian for both women and men, it was found that not all the women in the survey owning land were making decisions on the agricultural use of their farms. In many cases, they did not even control the profits from their farming activity. Of the female respondents holding independent land titles in Mendoza, only 11% made farming decisions on their own. Of the remainder of the cases, 36% made decisions jointly with their husbands, and in 53% of the cases only husbands or male relatives were the decision-makers.[107]

Less access to land rights not only implies less independent water rights for women but also less independent membership in WUAs as stipulated by the legal frameworks of Tigray and Mendoza. This implies that those women not being independent members in WUAs do not attend managerial meetings; their water needs are probably mediated by their husbands or male neighbours; they are not called for trainings and do not have the opportunity to become members of managerial water committees.

Holding legal water rights and being members of WUAs, however, may not necessarily guarantee sufficient water at the time people need it; water access for smallholders was found to be strongly linked to the condition of the hydraulic equipment and infrastructure. This technical dimension of irrigation agriculture clearly influences the ability of women and men to reliably and affordably access water. Most of the irrigation infrastructure found in the study areas of Tigray and Mendoza consists of earthen channels, which require significant physical effort for routine cleaning for water distribution. Furthermore, in both study locations, most farmers irrigating with surface water were using irrigation systems that require opening and closing furrows with a hoe. This causes disproportionate difficulties for women to practise irrigation because of the physical demand. Therefore, women need the assistance of family members or hired labour to practise irrigation. In the lowlands of Tigray, where most of the new irrigation systems established by governmental programmes are

[107] Source: Survey of farmers in Mendoza. July-December 2016; May-June 2017.

pressurised, women find it easier to irrigate – as there is no need to construct furrows with oxen or to distribute water manually.

In all study locations, maintenance of irrigation infrastructure was deficient (e.g. broken canals and water gates, infilled reservoirs). As a result, water is often not properly distributed to all farms. This requires negotiations with neighbours and WUA leaders to re-arrange water turns. Men usually have more mobility and social connections with WUA leaders and are less socially constrained to make successful agreements. In Mendoza and the lowlands of Tigray, water turns are usually supplied at night due to the warm weather conditions. This was found to be a critical constraint for women in irrigation practice. Women could not irrigate at night alone due to security risks (robberies and sexual harassment) in both Tigray and Mendoza. Additionally, cultural norms restrict independent mobility of women in Tigray.

Study results found that security of water access is also influenced by the time constraints because of the demands on farmers' time placed by communal WUA activities. In Tigray, traditional gender roles and division of labour were found to be strong, with men mostly in charge of farming tasks, but women nevertheless performing a large share of farming activities (Imburgia et al., unpublished manuscript-c). In addition, women are responsible for most of the domestic tasks, which in rural areas of Ethiopia are very time-consuming (Imburgia et al., unpublished manuscript-c). For example, all interviewed farmers needed to fetch drinking water from a communal water source located outside their compounds. They also had to collect firewood for cooking and heating. Women and girls were responsible for the largest part of both activities. Likewise, a lack of affordable and reliable energy sources and technology rules out the use of time- and labour-saving implements for cooking (e.g. manual mill for grains; improved cooking stoves). As a result, women have much less available time to participate in all activities related to irrigation management. These activities include participation in regular (usually weekly) WUA meetings, where irrigation schedules are discussed, and monthly meetings where other agricultural issues are discussed (e.g. pest management programmes and market updates). Female landowners, mostly heads of households, are allowed to be absent from the weekly meetings. This implies that they have no saying in setting water delivery schedules.

In the case of Mendoza, a higher proportion of men than women were found performing irrigation tasks; however, women's involvement in agricultural activities appeared to be related to whether belonging or not to a family with strong farming traditions (Imburgia et al., unpublished manuscript-c). In Mendoza, workloads related to domestic tasks are less time-consuming and demand less physical effort for women and men than in Tigray. For example, rural households do not need to fetch water or firewood as they have their own supply. While rural women in Mendoza held a more prominent domestic role than men, husbands and sons were found sharing some domestic responsibilities. Therefore, the workloads of farmers are less of a constraint to fulfil WUAs' responsibilities. Nonetheless, participation of farmers in WUAs' activities was found to be low for all members, and minimal for women. Results from FGDs revealed that impoverished rural families may decide that women stay at home and do the household work, including taking care of children and elders, while men work on the farm (except in those cases where men have off-farm jobs and therefore, women are more involved in farming).[108]

Gender differences in workload (and therefore in participation) of the different social groups are not static, even within the same research region. Socio-cultural factors shape these differences. For example, while women in the highlands of Tigray help in soil preparation and cleaning field channels, social norms do not allow those tasks for women in the lowlands. In Mendoza, groups of women with a strong farming tradition (including those migrants from the north of the country and from Bolivia) were generally very busy with numerous farming tasks and most of the domestic work.[109] Instead, criollas (women born in Mendoza and being of European descent), were found generally less involved in farming tasks but assisting in farm administration tasks. It is also important to note that gender roles might be changing rather quickly, in particular in peri-urban areas where accessing off-farm jobs is easier.

Security of livelihood strategies

The gendered analysis of this outcome is vital as access to irrigation is a key factor to make farming a viable livelihood strategy to cope with poverty and food insecurity in Ethiopia (Haile and Kasa, 2015). For example, findings from a parallel study in Tigray found that smallholders cultivating irrigated land were better able to secure subsistence than those

[108] FGD with male farmers, Mendoza River Basin [A_3aM-G-01] 30/08/2016; FGD with female farmers, Lower Tunuyán River Basin [A_Ti-G-09] 31/05/2017.

[109] FGD with female farmers, Lower Tunuyán River Basin [A_Ti-G-09] 31/05/2017 and survey to farmers in Mendoza, July-December 2016; May-June 2017.

having only rain-fed land (Imburgia et al., unpublished manuscript-c). That empirical study also shows that irrigation supports the subsistence farming efforts of independent women, as well as vulnerable farmers, for example, elders, youth with no other income options, and women and men returnees from migration.

In Mendoza, almost half of the irrigated land is dedicated to small-scale farming (Imburgia, 2017); however, profitability of SSIS is seriously at risk due to persistent national financial crises that make it very difficult to invest in improved practices and more efficient irrigation systems. Interviews with leaders of WUAs revealed a large number of farms with almost no maintenance, or even abandoned farming plots, because farmers cannot afford to maintain their lands.[110] FGD findings also revealed that it is considerably more difficult for many women farming on their own to stay in the activity not only because of constraints related to the physical and managerial aspects of irrigation, but also because women farming on their own have higher costs, cultivate less land, and earn less income from farming; therefore, they may have less financial capacity to invest in modernisation of irrigation systems. This in turn, has a negative effect on productivity of female-operated farms and even on their ability to stay in the activity (Nation, 2010). This partly explains a decrease in female participation in the small-scale agriculture sector in Mendoza, as indicated by the survey and results of FGDs. Some rural women state they did much more in farming in the past, when there was less of a need to earn off-farm income.[111]

Autonomy

This outcome relates to the ability to independently access and control resources (Agarwal, 1997) and the 'ability to exercise choice' (Kabeer, 1999) once irrigation water and agricultural livelihood are secured. This study shows that farming as a livelihood alternative provides the main independent source of employment for many women and men with limited opportunities to access off-farm jobs.[112] For example, a female farmer growing vegetables in Mendoza explained: ‘I’d like to be doing something else, like working in a shop in town

[110] Interviews with manager of a second grade WUA, Mendoza River Basin (male) [A_3aM-ID-05] 28/07/2016; WUA leaders, Mendoza River Basin (male) [A_3aM-ID-06/07/08/09] and FGD with WUA leaders, (male) [A_Ti-G-02] 15/09/2016.

[111] Surveyed women, Mendoza River Basin [A_3aM-S-04/10] 25/08/2016; [A_3aM-S-11] 01/09/2016.

[112] FGD with female farmers, Lower Tunuyán River Basin [A_Ti-G-09] 31/05/2016.

or having my own business. But I didn't study. The only thing I have is this land'.[113] On the other hand, farming is a livelihood strategy of choice for women who have their own land and prefer an independent source of income. In FGDs in the lowlands of Tigray, female farmers reported that since several of them had divorced their husbands in order to get out of conflictive marriages, they had also received half of their land as a result. For this reason, they felt 'at peace', in addition to the fact that they had started to progress economically.[114] These examples particularly show that irrigated agriculture - as an independent livelihood strategy - has an empowering potential, provided women have their own land and access to water.[115]

Adaptive strategies

Lastly, this outcome relates to the adaptive strategies that farmers use to manage the increasing incidence of water shortages and unpredictable environmental changes. Empirical findings showed that a typical strategy used by both female and male farmers interviewed in both countries was to resort to informal agreements to maintain sufficient access to irrigation water. Interviewed farmers mentioned that WUAs would try to schedule water distribution according to crop demand and swap or split water turns among neighbours. Yet, FGDs with water officials indicated that while in some cases these informal arrangements were a useful fix to the system, in other cases those informal rules allowed for abuses of power that may include favouring friends and relatives. Women and men not well-connected to WUA leaders were unlikely to benefit from those informal agreements. In both countries, a small number of smallholders were able to dig their own wells (i.e., shallow wells in the highlands of Tigray and deep wells in Mendoza) to mitigate water shortages. However, this option was only affordable for well-to-do farmers, irrespective of gender.

The need to rely on those types of adaptive strategies indicates the urgency to expand water-saving irrigation systems at the farm level. In the lowlands of Tigray, the pressurised irrigation systems implemented through government subsidies (although with deficiencies in operation and management), showed positive outcomes for farmers, particularly for women, for whom the irrigation practice became easier. In Mendoza with currently low

[113] Married, female farmer, Mendoza River Basin [A_3aM-S-11] 01/09/2016.

[114] FGD with female farmers, heads of household, lowlands [E_Ka-G-03].

[115] For a detailed analysis, see Imburgia et al. (manuscript unpublished-c).

profit margins, basically only larger commercial farms can afford such system upgrades. Nevertheless, promotion of new irrigation technologies requires cautious evaluation of the gendered outcomes to ensure equitable use, control and benefit share between men and women (Oates et al., 2017; Theis et al., 2018). Fieldwork showed that male and female smallholders, already constrained in secure water access, agricultural livelihood strategies and autonomy, were clearly less able to adapt their production to increasingly unpredictable rainfall and low profitability of small-scale agriculture. Many women in this study appear disproportionally disadvantaged in their adaptive capacity, with constraints including a lack of access to capital, information, knowledge, and time. This adds to previous evidence (Parker et al., 2016) and must be considered in future support and development programmes because farmers forced out of the sector lose a critical livelihood option.

5.6. Conclusions

A novel integrative gender-analytical framework was applied to research NRM governance in two case studies of self-governed communal small-scale irrigation systems, from widely differing cultural and economic settings. Results support the notion that the management of a scarce natural resource for agricultural production must respond to very complex interaction networks of factors that determine outcomes at multiple scales. In order to better understand how these outcomes are gendered, an analysis model was conceived that joins and extends three theoretical concepts (FPE, SES, and social relations framework). By explicit consideration of gender-specific technical constraints to full participation in irrigation practice and governance (above and beyond those commonly recognised as consequences of gender and power relations), it opens a practical perspective on policies and interventions in the development of SSIS that effectively and comprehensively address gender issues. For example, technical design of irrigation systems, extension programmes for the improvement of irrigation governance, and training programmes for female irrigation farmers, would all benefit from a gender analysis based on this integrative framework. A joint view of socio-economic and technical issues seems to be required.

The application of the gender-analytical framework reveals how policy interventions are able to foster important changes in rather short periods of time. In Ethiopia, the reduction of gender inequalities by policy (e.g., on land tenure) allows women to secure irrigation water, food production and a decent income source. Finding showed an increased number of young, single and married women holding land certificates in their names as a consequence of the new land registration and certification policy. In less than four years since policy implementation, these women have improved their independent participation in farming, in WUA meetings, and they spoke of better confidence in their capacity to earn income. In Argentina, through joining participatory activities in the course of the study, women could access more information regarding the functioning of the WUAs and the irrigation sector. As a result, many of them indicated a growing interest in attending WUA's meetings and seemed more assertive about voicing their claims and issues with water.

On the other hand, the framework makes transparent a technical dimension of irrigation agriculture directly impinging upon gender inequality. Examples are presented of how specific technical properties of irrigation systems negatively affect women in a disproportionate way. In other words, identifying gender differences and inequalities in conventional gender analysis is necessary but not sufficient. Rather, the integration of technical properties of irrigation systems within gender analysis leads to comprehensive and effective policy and interventions when evaluated in the technical context of farming practice. For example, investment in irrigation infrastructure that reduces the physical workload in the practice of irrigation agriculture, would particularly help women farming on their own.

Furthermore, recent socio-economic processes in small-scale irrigation agriculture exacerbate gender disparities to the detriment of women. The increasingly low profitability of small-scale agriculture (typical for the subsistence type of agriculture in Tigray, and a rapidly threatening issue in Mendoza) puts at risk the viability of livelihood strategies of small and increasingly impoverished farmers, notably elderly and female farmers with caring responsibilities. In Tigray, these serious problems could be addressed by extension work providing knowledge in improved farming practices, access to market and the cost-effective use of irrigation water for high-value crops and crop diversification. In Mendoza, support is needed in the development of communal water-saving irrigation systems and infrastructure (e.g., water reservoirs, pressurised irrigation systems), plus support in accessing suitable financial instruments. The explicit consideration of specific financial, knowledge and capacity development needs of different groups of women is vital.

Interestingly, despite very significant cultural and socio-economic differences between study locations, the framework allowed to identify patterns common to both places, understand the effects of the interacting processes on governance outcomes and livelihood strategies, and highlight opportunities for sector policy and donor-funded interventions that are conducive to overcome gender and other social inequality constraints. Policy recommendations arising from these findings focus on the need for (1) explicit analysis of gender-specific effects of technical properties of irrigation development, (2) special attention paid on the design of tailored extension programmes for female and male farmers, and (3) support to overcome gendered cultural limitations to participation in the management and governance of irrigation systems. It seems advisable that researchers, project planners and implementers extend the 'usual' audience of their gender analyses to technical experts in irrigated agriculture, as they are typically not engaged in gender analysis of programmes. Consequently, the proposed framework provides a suitable platform for such integrative gender analysis, as it is also feasible to link the proposed framework with quantitative tools, used to collect and analyse gender-related data (e.g. WEAI), as well as with participatory research approaches.[116]

[116] For examples, see Kumar (2002) and Cornwall (2011).

6. Application of an integrative gender analysis of small-scale irrigated agriculture and women's agricultural livelihoods

This article has been submitted for review to the Journal of Development Studies. Authors: Imburgia, L., Osbahr, H., Cardey, S. and Momsen, J.

Abstract

While a number of conceptual approaches have contributed in broadening our understanding of women's involvement in irrigation, in practice those conceptualisations are difficult to convert into operational methodologies. This study applies an integrative gender methodological framework to examine the social and technical interactions of irrigation agriculture for the two most critical questions: why and how gender is an important factor in shaping access to secure, reliable, and affordable irrigation water for many female farmers? How is this gender factor influenced by social differentiation processes present across different cultural and socio-economic settings? Diversity of evidence and methods was obtained through a multicase mixed-method approach in Ethiopia and Argentina. This approach combined in-depth interviews with key informant interviews, focus group discussions and a survey of smallholders, administered in both study locations. The findings highlight that despite decades of prominent international gender policies, and greater visibility of women in farming, women in irrigated agriculture remain constrained by structural inequalities driven primarily by entrenched power dynamics, social relations and material inequalities. Even in countries with official policies supporting women's land rights and associated water rights (Ethiopia and Argentina are examples), women access less land and have lower independent membership in WUAs than men. The technical dimension of irrigation systems and management, and the social relations dimension of self-governance, while suited for the traditional roles and conditions of men in rural areas, place more physical, managerial and financial constraints on women. This reinforces gender asymmetries and unequal women's partipation. The article further illustrates the role of irrigation agriculture as a potential driver of social differentiation in rural societies, and, as an empowering livelihood option for women provided water access is secured.

Keywords: Small-scale irrigation, gender equality, water governance, property rights, social relations.

6.1. Introduction

Irrigation agriculture dates back at least 5,000 years (Sojka et al., 2002). Despite its significance as the catalyst of civilization and organisation of human society, only recently has it been recognised that women play a central role in irrigation agriculture - as beneficiaries, users, and actors in water organisations (Adams et al., 1997; Athukorala, 1996; Meinzen-Dick and Zwarteveen, 1998). This perspective contrasts with traditionally accepted views of women primarily associated with domestic water use, hygiene and sanitation (Wallace and Coles, 2005; Zwarteveen and Bennett, 2005; Van Koppen and Hussain, 2007).

Within the scholarship on irrigation and women, the emphasis has been placed on access to water. The right of access to irrigation water is usually associated with land ownership, where strong gender inequalities persist in many parts of the world (Agarwal and Herring, 2013; Meinzen-Dick et al., 2017). However, gender issues have also reported other perspectives, including irrigation water governance and participation of women; gender roles and identities in farming, and social relations of gender in water access and use (Meinzen-Dick and Zwarteveen, 1998; Zwarteveen and Meinzen-Dick, 2001; Cleaver and Hamada, 2010; Nation, 2010). All these perspectives have supported the development of gender policies specific to agricultural development. However, while representation of women in the governance of irrigation agriculture systems, such as water users' associations (WUA) has been made mandatory (for example in India, Sri Lanka, Nepal), this is often of a symbolic inclusion of women and frequently too formalised to function effectively in practice (Van Koppen and Hussain, 2007; Zwarteveen et al., 2010). Even more problematic is the limited consideration of the issues specific to the women's role in irrigation agriculture when it comes to the design of technical interventions (Centrone et al., 2017; Theis et al., 2018). Women (and some groups of men) have traditionally been excluded from water management planning, from irrigation infrastructure design and irrigation information and training in many developing countries (Cleaver, 1998; Momsen, 2010). This leads to the argument that those conversant with gender issues in agriculture at policy level are not always conversant with the technical specialities (and vice versa). A constructive, truly interactive dialogue between scholars, technical advisers in development and extension in irrigation agriculture and gender experts remains missing in practice. This can lead to ineffective programmes or missed opportunities in the technical development of irrigation systems, especially in the design and provision of extension services, and in ensuring governance conducive to resource conservation and equitable use. Recognising the value of taking a more integrated framework is vital.

While scholarship on the issues of gender and irrigation were highly active two decades ago, empirical, peer-reviewed studies with robust theoretical support are less prevalent in the literature recently.[117] This has been translated into poor implementation of potentially effective policy (Ray, 2007) as has been the case in broader aspects of women's rights (Cornwall and Edwards, 2015). Moreover, there is evidence that many technical intervention programmes in agriculture have led to significant acceleration of social stratification, undesirable shifts in power structures, and decreased equitability in access to resources and means of production, with evidence of women becoming a marginalised group in irrigation systems (Van Koppen, 1998; Zwarteveen and Meinzen-Dick, 2001; Harris, 2006; 2008; Lefore et al., 2017). The interactions between the technical and socio-economic dimensions of irrigation systems on women are thus becoming recognised (Centrone et al., 2017; Lefore et al., 2017; Imburgia, 2019) and as a consequence there is need that impact analyses become comprehensive *and* gender-explicit. The traditional (and for practice) gender-analytical frameworks (March et al., 1999) are mostly based on binaries and dichotomies: women/men, female/male head of household; views of a 'predatory' man and a powerless woman. Differences in class, status, age, and socio-cultural background are less prominent, and thus hierarchies within different groups of women and men being difficult to establish. While theoretical perspectives such as the feminist political ecology have contributed with more comprehensive and realistic gender and social differences in NRM analyses, their operationalisation remains challenging (Imburgia, 2019).

Accordingly, there is a need for an integrative framework that (a) provides a gender-explicit conceptual model of the interactions between the technical and the socio-economic dimensions of current irrigation agriculture, (b) identifies entry points for promising interventions, and (c) highlights critical junctures where disregarding gender issues will increase the likelihood of system failure. Such a conceptual framework was presented recently (Imburgia, 2019). This article applies this framework as a methodological tool to provide a detailed comparative analysis of two substantial different irrigation systems in the way agro-ecological, technical, infrastructural, financial and socio-cultural processes take

---

[117] Examples of recent significant contributions to this scholarship are Harris (2005, 2006, 2008); Harris et al. (2015).

place. In doing so, the paper seeks to improve understanding of two critical issues in irrigation and gender: first, why and how gender is an important factor shaping access to *secure*, *reliable*, and *affordable* irrigation water for many female farmers, and second, how this gender factor is influenced by processes of social differentiation present across different cultural and socio-economic settings. We review relevant literature to briefly summarise the key elements of the methodology and then present the results from the empirical investigation in Ethiopia and Argentina, before discussing the implications for policy and development practice in irrigation agriculture.

6.2. Conceptualising irrigation and gender

Studies of gender, women and irrigation have explored the multiple factors that influence the participation of women in irrigated agriculture. In the last two decades, water governance has been highlighted as one of the key priorities for policy makers and donor agencies (OECD, 2018; GWP, 2019). This has conditioned funding priorities by international development agencies and governments (Tortajada and Biswas, 2011; Lautze et al., 2014). Irrigation water governance is intrinsically social and political: it involves the participation and voice of different stakeholders, across all levels of decision-making (Boelens and Hoogendam, 2002). Water governance reflects an arrangement of social relations including those of gender, subordinated to diverse forms of power (Harris, 2015a). All forms of agreements on access to irrigation water correspond to a range of social relationships, and hold diverse degrees of security, equity and justice (Crow and Sultana, 2002; Joy et al., 2014). In rural areas in developing countries, access to water can be realised through formal or informal individual water rights, and by sharing other's rights, with or without consent of the right's holder (Ribot and Peluso, 2003). Water rights as a 'bundle of rights' includes diverse types of actors that may hold different types of rights (access and withdrawal; management; exclusion, and alienation), with critical implications to resource management determining 'incentives', 'actions' and 'outcomes' for rights holders (Schlager and Ostrom, 1992). Even though gender relations vary greatly, unequal power relations between men and women may result in generalised asymmetries mostly to the detriment of certain groups of women (Momsen, 2010). This explains why in the irrigation sector women access to water has been characterised by less formal ownership of water rights and persistent (less secure) mechanisms of informal access (Adams et al., 1997; Meinzen-Dick, 2014).

Gender, social relations and property rights have been extensively analysed for land tenure (Agarwal, 1994). A number of authors have explored the implications of the mechanisms of water rights acquisition for gender equity (for example, Boelens and Zwarteveen, 2002), as those rights are shaped by cultural symbols, traditions, local uses and values (Ahlers and Zwarteveen, 2009) and mostly vested in men (Zwarteveen and Bennett, 2005). Independent property rights for women help secure means of agricultural production, food security, control over the own income and strengthen bargaining power, while also helping access to credit, extension services and information (Meinzen-Dick et al., 2017).

Even though many women are farmers and base their livelihoods on crop production, women have traditionally not been considered irrigators by themselves, by their families or by projects (Bennett et al., 2005). Intra-household dynamics and limited financial capacity to invest in irrigation have been highlighted as contributing factors (for example, Nation, 2010). Other scholars have offered conceptualisations of women and irrigation water cross-cutting with poverty and socio-economic differentiation (Zwarteveen and Bennett, 2005; Harris, 2008), and gender and equity in neoliberal political and economic contexts (Ahlers and Zwarteveen, 2009; Harris, 2009). Although a poor link between the scholarship on water policy and the scholarship of gender was reported (Ray, 2007), there is no question today that women must be included at all levels of the water governance.

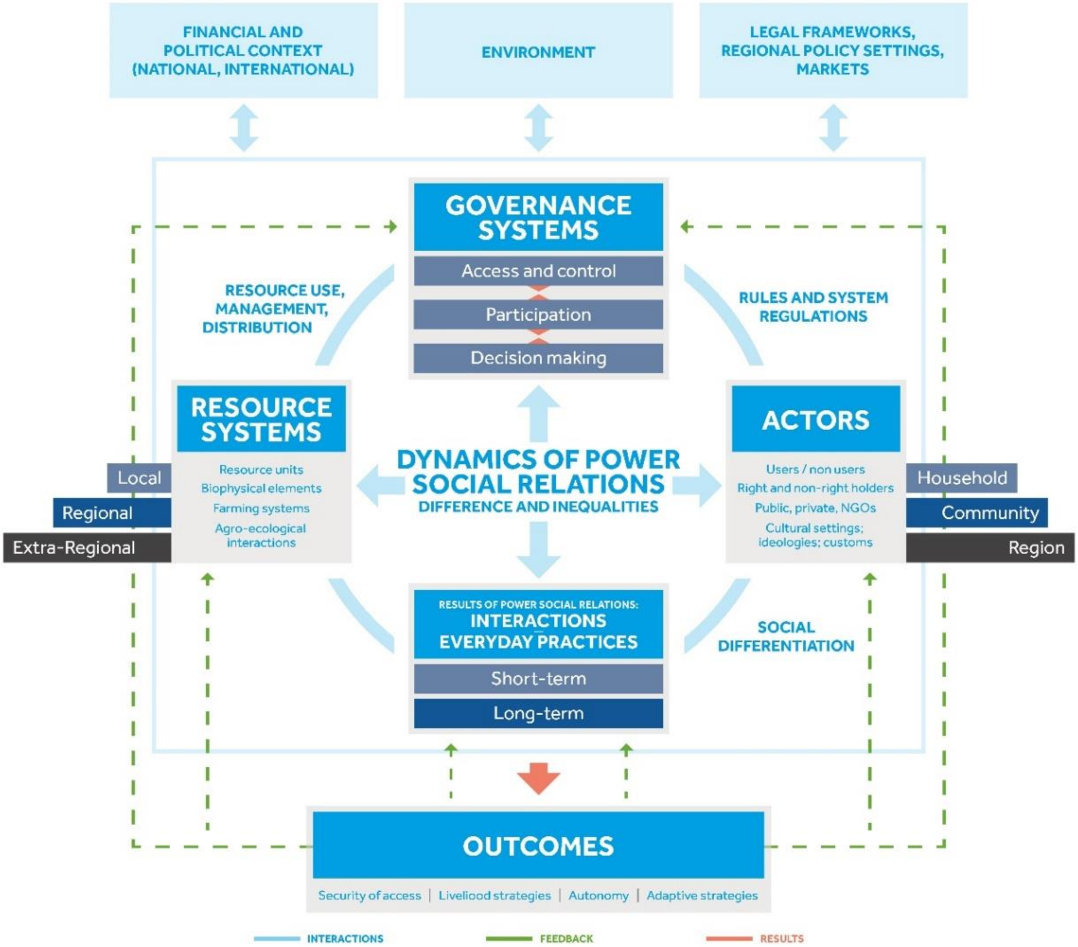
There are scholars who have integrated perspectives exploring water and gender, for example, by conceptualising *intersectionality* in irrigation, social differences, gender and power within the feminist political ecology approach (Harris, 2008; Thompson, 2016) as well as through analysis of governance, poverty and gender equity using the lenses of institutionalism and structuration (Franks and Cleaver, 2007; Cleaver and Hamada, 2010). While such approaches have contributed to broaden the understanding of women's involvement in irrigation – especially the issues shaped by social relations of power - in practice, these conceptualisations are difficult to translate into operational methodologies. To address this gap, this paper applies a methodological framework as a tool to organise empirical evidence that can help to facilitate translation into the practice of agriculture, irrigation and participation of gender.

The methodological framework applied here[118] focuses on the intersections and nuanced relationships of the technical and social relations aspects of small-scale irrigation systems (SSIS) in three key variables: access, participation and decision making (Imburgia, 2019). This framework was motivated by the analytical approach of the feminist political ecology (FPE), which aims at capturing the social differences and inequalities present in ecological, economic and development processes due to social relations of power (Rocheleau et al., 1996; Elmhirst, 2015). In order to introduce robustness to the 'ecology' aspect of the FPE framework the framework was combined with the conceptualisation of an irrigation system managed collectively as a social-ecological system (SES) of diverse complexity (Anderies et al., 2004), including their interactions and outcomes (McGinnis and Ostrom, 2014). For the further construction of this framework, appropriate elements of the social relations framework (Kabeer, 1994) were incorporated to more accurately examine gender social interactions that condition uneven access to (irrigation) water, imbalance in power and decision making.

By combining selected elements of the three theoretical ideas, FPE, SES and social relations frameworks, the integrative gender-analytical approach allows examining the nuanced dynamics of social relations that drive the processes and outcomes of irrigation governance (see Figure 6.1 below).

[118] For a detailed description of the development of the conceptual framework, see Imburgia (2019).

Figure 6.1 The integrative gender-analytical approach to natural resource governance



Source: Developed by the author.

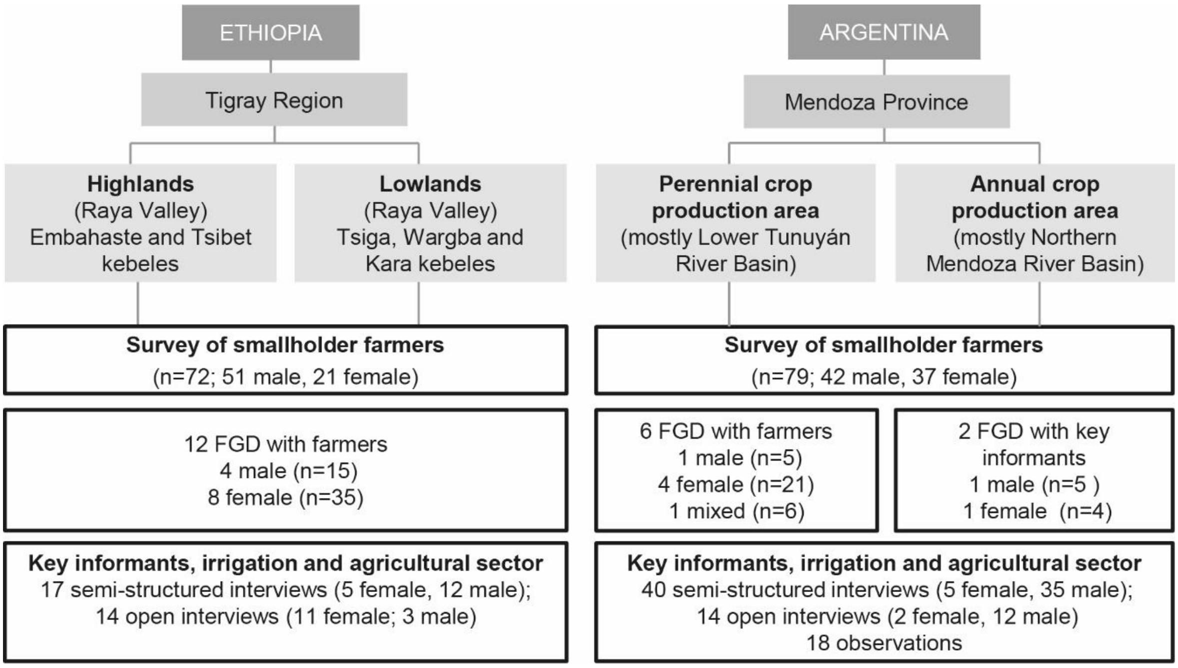
The functioning of irrigation systems, actors' actions and interactions define and are defined by social relations of power that catalyse all interactions among the different elements including the resulting every day activities (Kabeer, 1994) people perform when growing crops and irrigating. The intersections of these elements result in: resource use, management and distribution; rules and system regulations, and social differentiation. In combination these elements produce gendered outcomes of the irrigation governance system, which help examine the factors and mechanisms of women's involvement in irrigation. In the next section, the application of this framework will use empirical data from collective small-scale irrigation schemes to contextualise the outcome analysis of governance, i.e., resource systems, actors and governance systems, before discussing interactions among those elements and everyday irrigation practices, and the resulting intersections and outcomes.

6.3. Research approach and study areas

The study used a transregional multi-case mixed-methods approach to understand diversity in cultural and socio-economic settings, and associated analytical complexity. Fieldwork was conducted in the Raya Valley, southern Tigray (Ethiopia) and in Northern Mendoza irrigation basin (Argentina) during 2016-2018. These areas share three common features: a high representation of SSIS; some degree of irrigation water shortage (infrastructure deficiency and/or unpredictable water availability), and collective water management by WUAs. The mixed-method research approach included a stratified field survey to small-scale female and male farmers organised in WUAs; in-depth interviews and focus group discussions (FGDs) to purposively selected key informants (Figure 6.2)[119]. To explore the interactions between all key elements of collective irrigation systems (Figure 6.1), the Tigray and Mendoza study sites provide a useful representation of diverse irrigation and cropping systems (resource systems); various types of WUAs (governance systems) and socio-cultural backgrounds (actors).

[119] For anonymity of respondents, an identification coding system was used: reference letters for the country ('E', Ethiopia; 'A', Argentina), research site location, and research tool used ('S', survey; 'G', FGD; 'ID', semi-structured in-depth interview (individual); 'Op', open interview, and 'O', observation), and an interview order number. For example, for Ethiopia, the first survey conducted in Embahaste kebele is indicated as [E_Em_S-01].

Figure 6.2 Study locations in Tigray and Mendoza including qualitative and quantitative sample size



Source: Imburgia (2019).

The Raya Valley is a semi-arid area with an agricultural-dependent economy. Rains are bimodal (486 to 693 mm per year) (WWDSE, 2015), relatively erratic and unpredictable. Access to irrigation therefore increases security of the farming livelihood, the most important economic activity in this region. In the highlands, all irrigation is done with surface water distributed through communal earthen and lined channels, and furrow irrigation systems. In the lowlands, most of the irrigation is done with groundwater; smallholders used furrows and pressurised irrigation systems (drip and sprinklers). All farmers surveyed were of Tigrayan origin and got incomes from crop production; 65% of the male-headed and 40% of the female-headed households also had incomes from livestock. Surveyed women and men were found growing similar crops in irrigated fields: vegetables, cereals, pulse and fruits. In rainfed plots, barley and pulses (highlands), sorghum (lowlands), teff, wheat and maize (both) predominated. In some areas of the lowlands, fruit trees (of recent introduction) were also grown including mango, papaya and avocado. Farming was mainly based on traditional techniques with poor agronomic practices, and insufficient and poorly equipped extension service support. Profits from farming were generally low as input costs were high and market prices for cash crops were usually low (most farmers grew the same crops at the same time). All farmers access irrigation water through their participation in WUAs of diverse type, i.e., traditional WUAs in the highlands and newly developed WUAs in the lowlands (Imburgia et al., unpublished manuscript-b).[120]

The northern Mendoza irrigated region is an arid area - average rainfall of 250 mm (DGI, 2016) - that depends exclusively on irrigation for farming. Surface water (under a well-organised governance structure) and groundwater (privately managed with supervision of the water authority) are both used for irrigation. Most smallholders use furrows and flood irrigation. Plots in the perennial horticulture study areas are commonly dominated by one crop, mostly wine grapes (76%), and stone fruits. In the vegetable areas, farmers rotate several crops per season (mostly tomato, leafy vegetables, garlic and onion). Most smallholders use basic agronomical practices with low rates of innovation and investments. More frequently, farmers receive ad hoc technical assistance from private input vendors. The structure of the farming sector is dominated by small and medium size, mostly family-unit producers; of the survey respondents, 96% of perennial crop growers were of *criollo* origin (farmers born in Mendoza and being of European descent), one migrant from the north of the country (*norteño*), and one from Bolivia. Of the respondents in annual crop productions, 62% were *criollos*, 20%, *norteños*, and 18% from Bolivia. Productivity and profitability of the agricultural sector have been negatively impacted by high rates of inflation and currency devaluation, exacerbating the negative effects of a prolonged drought (since 2005/2006). Mendoza has a well-established irrigation governance system that includes mandatory membership in WUAs of the command area (Imburgia et al., unpublished manuscript-b).[121].

6.4. The gendered outcomes of water governance

By applying the methodological framework, four outcomes (see bottom of Figure 6.1) synthesise the core elements of the functioning of the collective irrigation governance systems in place in both Tigray and Mendoza: (1) security of access to irrigation water; (2) security of livelihood strategies; (3) autonomy, and (4) adaptive strategies. The analysis of these outcomes provide key entry points to explain why and how gender differences

---

[120] The governmental Proclamation on irrigation WUAs (nº 841/2014) provides detailed stipulations of the different types of WUAs. Also, see Imburgia et al. (unpublished manuscript-b) for detailed descriptions of differences in irrigation management in Tigray.

[121] See Imburgia et al. (unpublished manuscript-b) for a detailed description of the irrigation governance systems of Mendoza.

(Thompson, 2016), shape access, use and participation in irrigation. These outcomes will be used to organise the empirical evidence as follows below.

(1) Security of access to irrigation water

A cornerstone outcome of irrigation governance is security of access to irrigation water. This outcome is mostly related to legality, thus the legal framework for property laws and entitlements; how reliable and affordable water access is, and the ability to get and use water due to physical capacity and workload constraints (Imburgia, 2019).

Legality. In Ethiopia and Argentina, by law, all users with land rights are entitled to water rights from communal water sources. This basic entitlement extends to the charter of WUAs with their rights and obligations. However, in practice, security of water access is affected by differences and inequalities related to access to property rights, membership in WUAs and related rules and policies. In both locations, women owned less land than men, and therefore, access less independent water on their own right. Imburgia (2019) found that in Ethiopia, there was a lower number of women as sole owners of land (22.6%) of which the overwhelming majority (93%) were household heads. Land was registered jointly for married couples in only 12.9% of the cases. In male-headed households, all men but one were owners of the land. In Ethiopia, land rights certificates used to be issued in the name of the household head - traditionally a man. A recent land law (the 'Second Stage of Land Registration and Certification' of 2014) allowed joint registration of new land certificates by spouses (Holden and Tilahun, 2017), or, according to informants, indicating the name of the spouse in land certificates issued before this policy. While the impact of this policy change was not yet evident in 2016, the 2018 women FGDs showed an increasing number of young unmarried and married women acquiring irrigated land certificates of their own. In Mendoza, of the total registered names of 2,123 land titles corresponding to agricultural water rights in the nine WUAs studied showed that an average of 31% of the titles were registered in women's name. Results from the survey clarified that only 22% of the farmers' land titles were in a woman's name alone, and 9% as dual titles (a male and a female members of the family own the land).

The right to access irrigation water is realised in Mendoza and in the lowlands of Tigray by membership in formal WUAs. In the highlands of Tigray, instead, security of water access varies according to the degree of formalisation of WUAs. Although membership is voluntary, it has increased security of access to irrigation water, in particular for less powerful farmers and vulnerable water users (usually elderly, persons with disabilities and many female-headed households). In Tigray, WUA leaders (*abomay* in Amharic language) indicated that before the formalisation of the irrigation associations any person could take whatever amount of water wanted[122]. A key informant from the lowlands commented: 'Before the association, water was only for rich, powerful people of the community. Now every person is equal and has the same right to access water'[123]. Similarly, women heads of household explained that in the past they needed 'to fight' to get irrigation water if they did not have a strong son or husband[124]. A female *abomay* explained: '[…] perhaps you got water, but when the crop died. Now, it's by schedule. When you have your turn, you get your water'.[125]

The exercise of the power that government holds over water users through a number of local policies may reinforce or weaken security of access (Meinzen-Dick, 2014). For example, in southern Tigray, the access to water for disadvantaged groups is facilitated by governmental irrigation programmes for landless female and male youth organised in cooperatives. In Mendoza, the implementation of more transparent methods to gauge and distribute irrigation water (for example, use of gauging stations that send real time data by internet) in certain WUAs has improved equity in access to water when compared with those that have not introduced such methods yet. By contrast, even when farmers hold land certificates, the degree of water security may be challenged by rules and policies pursuing objectives other than water management. For example, in Tigray, farmers perceived a risk of losing their land if they did not apply fertilisers[126] (sold and distributed by the government), and/or if they did not farm their land for a certain period of time.[127]

---

[122] FGD with male *abomays* of the highlands [E_Tb-G-02] 03/02/2016.

[123] Interview with *abomay* in the lowlands (male) [E_Tsi-ID-02] 05/02/2016.

[124] FGD with female farmers, highlands [E_EM-G-01] 02/02/2016; FGD with female farmers, head of household, highlands [E_EM-G-02] 13/03/2018; interview to female farmer, highlands [E_Tb-Op-2] 04/02/2016.

[125] Interview with *abomay* in the highlands (female) [E_Em-ID-2] 15/03/2018.

[126] In Tigray, a governmental rule makes mandatory the purchase of fertilisers; in irrigated areas, farmers must purchase fertilisers in order to receive irrigation water. Source: Fieldwork in Tigray, 2016/2018, for example, interview to agricultural officers in the lowlands [E_Ka-ID-01] 27/01/2016 and [E_Ka-ID-02] 05/02/2016.

[127] As in Ethiopia the land belongs to the state, farmers have a land use right that can be revoked if they do not farm the land for more than two years. Landowners can also lease the farming plot. Source: Fieldwork in Tigray 2016/2018.

Reliability. In both countries, irrigation inefficiencies due to infrastructure or management faults appeared as a source of inequality in water distribution for all users. Even when farmers hold water rights, water distribution is not always reliable due to improper distribution (unlined channels, garbage blocking flow, broken floodgates or broken pumps). Deficiencies of the irrigation system management force many farmers to develop their own 'working rules' (Adams et al., 1997) to satisfy their water needs. However, fairness of those agreements is dependent on the goodwill of the WUA leader, what decreases access security. In Tigray, the amount of water distributed and the irrigation timing were defined by the WUAs in weekly meetings. Many women were allowed to not participate acknowledging their high domestic workload. Their water needs were mediated by a male relative or neighbour. In Mendoza, water distribution turns were defined by the WUA leaders mostly with little say from farmers.

Affordability. Even when holding a legal right and having reliable access, the degree of security of irrigation water is determined by the financial capacity to produce and to pay the water fees. Therefore, profitability of the small-scale agricultural sector is critical for secure access to water. In both countries, smallholders find it challenging to stay in the irrigation system when (usually small) profit margins are threatened. For example, in Tigray, the compulsory fertiliser programme, while perhaps well intentioned, imposes a financial burden frequently not followed by increased profitability due to technical deficiencies, at risk of the need to leave farming[128]. In Mendoza, results from the survey showed that only 28% of SSIS with perennial crops and 62% of vegetable growers were able to live exclusively from farming. A large number of smallholders (67% in perennial and 20% in annual crops) interviewed subsidise their agricultural activity with retirement incomes, off-farm employment, leasing of land, and/or by incurring debts, for example, with the Water Administration office, in order to maintain their landholdings.

Water fees in the highlands of Tigray were rather low as most of the irrigation infrastructure was maintained by the farmers. In the lowlands, key informants reported returns from farming were hardly covering the electricity cost for pumping groundwater[129]. In Mendoza, surveyed farmers found the cost of irrigation affordable when agricultural incomes were

[128] Interview with *abomay* in the lowlands (male) [E_Tsi-ID-02] 05/02/2016.

[129]WUA leader, lowlands (male) [E_Wa-ID-03] 06/02/2016.

good (44%). Otherwise, water fees were perceived as excessive (41%). The remainder of farmers was unsure of the amount paid.

In both Tigray and Mendoza, all other things being equal, women on their own must have more capital available for irrigation than men, because they incur in higher costs due to their need to pay labour for ploughing, for irrigating at night and for cleaning earthen channels when this is physically too difficult for them or they do not have an elder son on the farm. As a result, many women were found cultivating less land than men, earning less income due to engaging in share cropping arrangements or, leasing or selling their farms[130] and leaving agriculture.

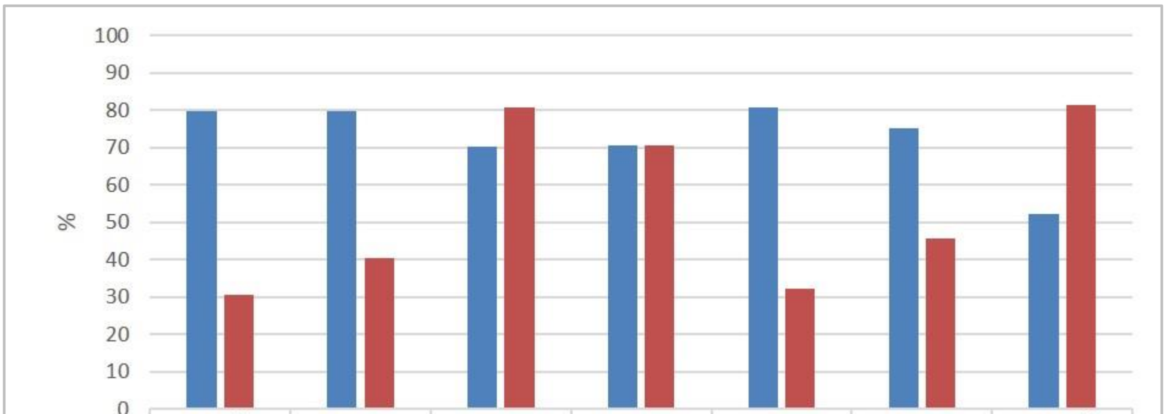
Physical capacity. Women farming on their own were found facing more difficulties to perform irrigation maintenance work, what often determines that women do not assert their formal water rights. In both countries, cleaning a shared part of irrigation channels is a farmer's responsibility (Imburgia et al., unpublished manuscript-b). This is usually a physically demanding task for women. In Mendoza, in addition to the physical difficulties, cleaning canals is dangerous for women in isolated rural areas because of violent crime. Furthermore, land preparation for furrow irrigation demands a physical effort that most women try to avoid. In the lowlands of Tigray, cultural norms prevented women from performing those activities. Improved irrigation infrastructure and technologies that reduce the drudgery of soil preparation, canal cleaning and time required for irrigating appeared to help women assert their water rights. Irrigation technologies such as drip or sprinkle demand much less physical work, and were preferred by female respondents in Tigray because they allowed to irrigate without hired labour. In Mendoza, the water agency has prioritised increasing the area of lined channels, which drastically reduces the need for hired labour.

Workload. Securing water access by men and women and their level of involvement in irrigation are linked to their workload (Centrone et al., 2017), which in turn is determined by the differentiated gender roles in agriculture and in domestic duties. In Tigray, as crops were usually not differentiated by gender, husband and wife were found sharing most farming tasks in the same plots; participation of women in those tasks (see Figure 6.3 below)

[130] This applies to Mendoza, where the land is of private ownership.

varied according to the position in the household, marital status, age, type of farming task and locality.[131]

Figure 6.3 Participation frequency diagram of women and men in production tasks - Tigray



	Land preparation	Sowing	Weeding	Planting	Irrigating	Harvesting	Preparation for market
Male	79.7	79.7	70.2	70.6	80.8	75.0	52.1
Female	30.4	40.5	80.6	70.6	32.3	45.6	81.2

Source: Survey of farmers in Tigray, January-February 2016; March 2018. N=68. Survey participants were asked who in the household performed each activity.

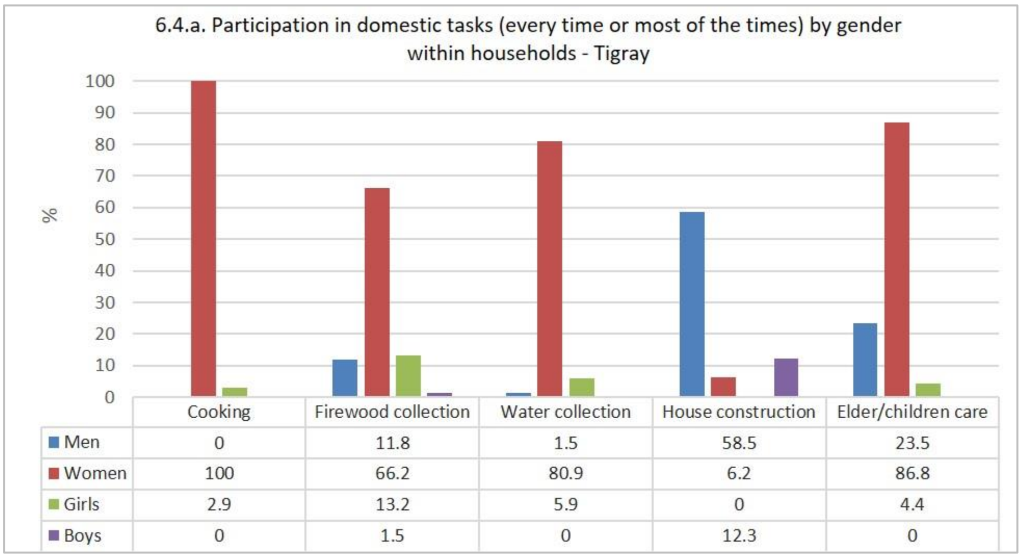
In Tigray, many more women were found irrigating in the highlands (42.9%) than in the lowlands (25%). This is explained by the fact that highland women had comparatively fewer constraints than lowland women in performing activities farther away from their homes. In the FGDs, many women, in particular those married and of reproductive age, often have little time available for farming due to their child care duties and other domestic chores as shown in Figure 6.4 below. While this is so in most similar contexts, the capacity of women to organise their time and duties and resort in family help is often underestimated by extension and development project staff. As a result, most women are not invited to training courses or other activities related to WUAs[132] with impact in their decision making share in irrigation. Although many women prefer not to spend time in meetings, for some this decision is not made based on a preference but on a lack of options. Married women in Tigray were found attending WUAs' meetings only when husbands were not available. For many women, the length and timing of meetings were inconvenient. This in turn, reinforced their prominent domestic roles, which in Ethiopia are time consuming and demand

[131] For additional results of gender distribution of work in farming, see Appendix 17.

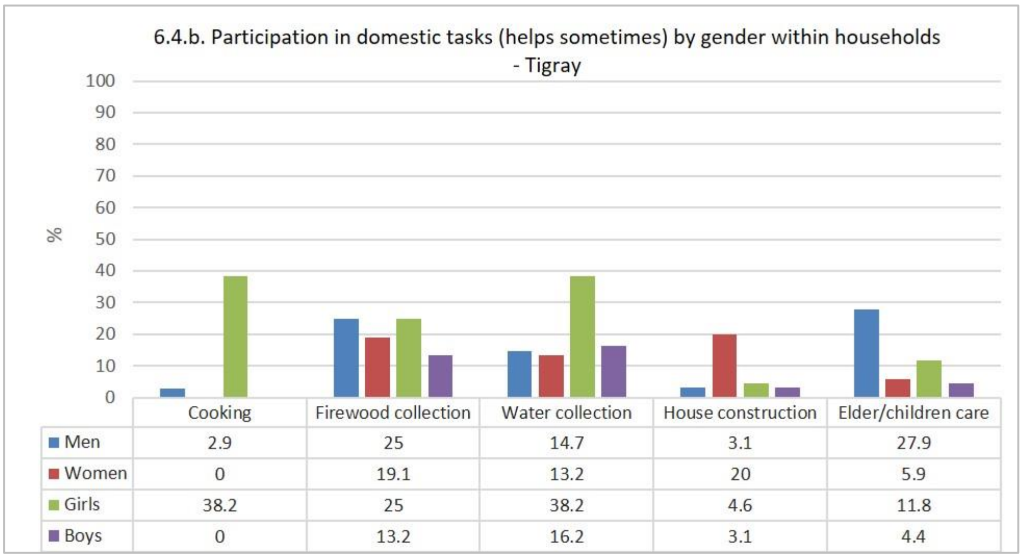
[132] FGD with female farmers in the highlands, heads and non-heads of household in the highlands [E_Em-G-03] 15/03/2018 and in the lowlands [E_Wa-G-02] 16/03/2018; FGD with female farmes non-head of household [E_Ka-G-04] 16/03/2018.

significant pyhsical effort, for example, when fetching water and firewood for domestic use (Imburgia, 2019).

Figure 6.4 Participation frequency diagram of household members in domestic tasks– Tigray



	Cooking	Firewood collection	Water collection	House construction	Elder/children care
Men	0	11.8	1.5	58.5	23.5
Women	100	66.2	80.9	6.2	86.8
Girls	2.9	13.2	5.9	0	4.4
Boys	0	1.5	0	12.3	0



	Cooking	Firewood collection	Water collection	House construction	Elder/children care
Men	2.9	25	14.7	3.1	27.9
Women	0	19.1	13.2	20	5.9
Girls	38.2	25	38.2	4.6	11.8
Boys	0	13.2	16.2	3.1	4.4

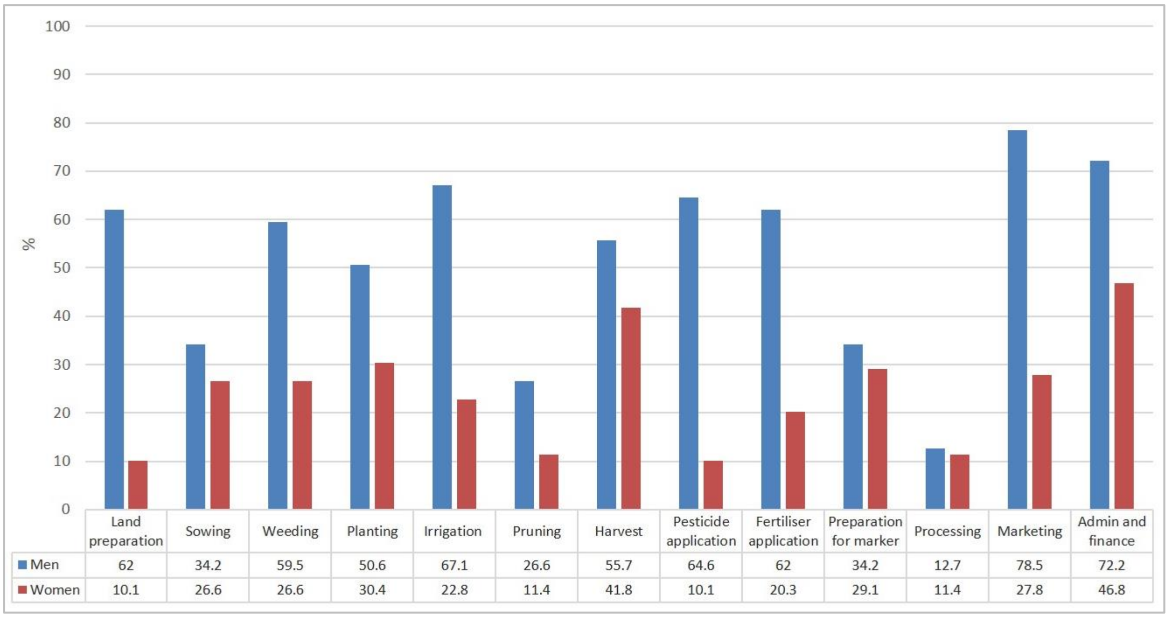
Source: Survey of farmers in Tigray, January-February 2016; March 2018. N= 68. Survey participants were asked who in the household performed each activity most of the times (6.4.a) or sometimes (6.4.b).[133]

In Mendoza, contrasting with female agricultural roles in Tigray, findings indicated a much lower representation of women working in the family farming unit. Field data showed that the women's workload due to farming and irrigation activities was found to defer according to the cultural background of the women. Interviews showed that in *criollo* households

[133] The number of respondents for this question by activity was n=68 (cooking and cleaning home; elder/children care and helping children with school) and n=65 (house construction).

where the man is usually considered the farm head, the woman identified herself as a helper, which may explain her lower participation in farming tasks (Figure 6.5).[134]

Figure 6.5 Participation frequency diagram of women and men in production tasks - Mendoza



Source: Survey of farmers in Mendoza, July-December, 2016; May–June, 2017. N=79. Survey participants were asked who in the household performed each activity.

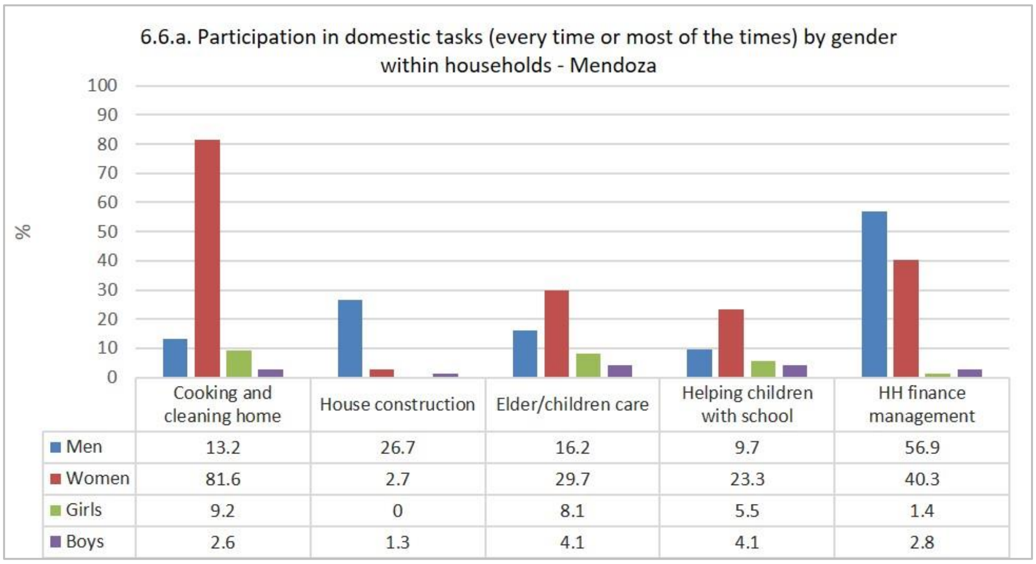
In the study sites of Mendoza, a much lower number of women than men were found performing irrigation tasks. Female migrants from Bolivia appeared more involved in all sort of farming duties than local *criollo* women. However, Bolivian women hardly participated in WUAs' meetings, due to cultural norms that limit their participation in public activities other than their traditional community gatherings. Interestingly, interviewed *criollo* women had a greater share of off-farm tasks, such as farm administration and paperwork, probably explained by the relatively high rates of education in comparison with female migrants from Bolivia. These findings illustrate how intersecting social factors other than gender (including education, cultural background, life cycle and marital status) help more accurately explain practicalities of water management (Thompson, 2016). Domestic roles in Mendoza,which demand less time and physical effort than in Tigray[135], are most frequently a woman's responsibility with help of husbands and sons as shown in Figure 6.6 below.

---

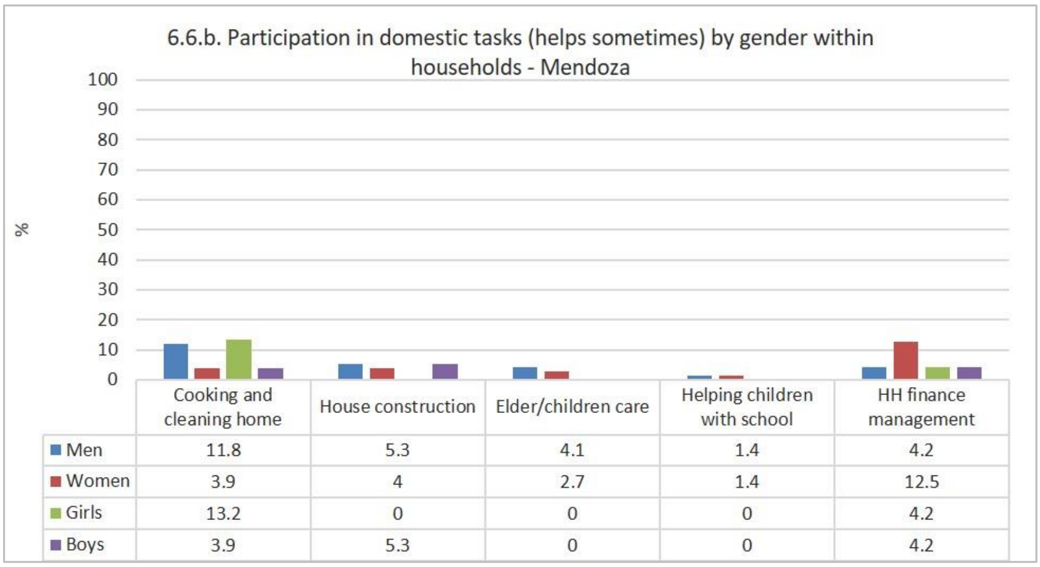
[134] For additional results of gender distribution of work in farming, see Appendix 18.

[135] In Mendoza, most households interviewed had a supply of drinking water and gas to cook. Source: Fieldwork in Mendoza 2016/2017.

Figure 6.6 Participation frequency diagram of household members in domestic tasks – Mendoza



	Cooking and cleaning home	House construction	Elder/children care	Helping children with school	HH finance management
Men	13.2	26.7	16.2	9.7	56.9
Women	81.6	2.7	29.7	23.3	40.3
Girls	9.2	0	8.1	5.5	1.4
Boys	2.6	1.3	4.1	4.1	2.8



	Cooking and cleaning home	House construction	Elder/children care	Helping children with school	HH finance management
Men	11.8	5.3	4.1	1.4	4.2
Women	3.9	4	2.7	1.4	12.5
Girls	13.2	0	0	0	4.2
Boys	3.9	5.3	0	0	4.2

Source: Survey of farmers in Mendoza, July - December 2016; May – June 2017. Survey participants were asked who in the household performed each activity most of the times (6.6.a) or sometimes (6.6.b).[136]

(2) Security of livelihood strategies

A second emergent outcome indicates that secured access to irrigation allows iteratively securing the livelihood strategies of SSIS, vital in the study areas of both countries. To exemplify the livelihood implications of securing irrigation water, we present typologies of farmers according to access to irrigated land identified by informants in Tigray (Table 6.1): farmers with irrigated land were found to be better-off than farmers who only had rainfed land. Even owning a small plot, farmers using irrigation were not considered poor, thus, they

---

[136] The number of respondents for this question by activity was: n=76 (cooking and cleaning home); n=75 (house construction); n=74 (elder/children care), and n=72 (helping children with school and household (HH) finance management).

were able to secure subsistence. Interestingly, irrigation benefited particular groups especially women, despite women generally being poorer. Further analysis of Tigray data showed that degrees of poverty of farmers with irrigated land are closely related to poor farming practices, limited agricultural knowledge and poor marketing and managerial skills, all aspects where women are comparatively more constrained. Similar issues were previously identified in southern Tigray (Yohannes et al., 2017). Overall, these interactions of irrigation access, irrigation practice and gender have implications in the livelihood processes that in turn affect the long-term viability of self-governed SSIS.

Table 6.1 Typologies of irrigation farmers of Tigray according to informants' responses

Category	Characteristics according to informants	Illustrative quotes
Better-off farmers	Irrigated land; 2-10 hectares in the lowlands; rainfed land. Use improved farming techniques. Keep livestock (up to 50 animals). Have a 'good' house, may have another house in town; send children to school. Not many in the highlands. No women included in this category.	*'It depends on the amount of hectares, but the important thing is to have links to market, and know-how for farming. A farmer may have a lot of hectares but nothing in the bank'.* Female farmers [E-Wa-G-01] 02/02/2016. *'This kebele [Kara] is rich by chat*[137] *and irrigation. There is a deep borehole here'.* Agricultural officer (female) [E_Ka-ID-02] 05/02/2016.
Average farmers	Irrigated land; 0.5-0.75 hectares in the highlands; up to 2 hectares in the lowlands. Some also have rainfed land and some livestock (1 to 10 animals). May also rent land. May have an additional income as labourer or guard. Some household heads women belonged to this group.	*'People from irrigation are improving their lifestyle. If a person has irrigation, she isn't poor.'* Irrigation expert, highlands (female) [E_Em-Op-01] 02/02/2016. *'Here [highlands] farmers make their money growing a lot of crops: sasella, potatoes, carrots and others.'* Irrigation expert, highlands (female) [E_Tb-Op-01] 04/02/2016.
Poor farmers	Irrigated land; 0.25 hectares in the lowlands and up to 0.625 hectares in the highlands. No livestock or only 1 or 2. Lack of capital and knowledge of improved agronomic practices. Farming only allows subsistence. Some women use sharecropping. Most women surveyed belonged to this group.	*'With ¼ tsimit [1/16 hectare] it's possible to feed my family, working day and night, having 3 harvests per year.'* Male WUA leaders [E_Tb-G-02] 03/02/2016. *'During drought, I need support. I cannot buy [food] for household consumption. If it's a good season, I can buy food.'* Male farmer, lowlands [E_Wa-ID-01] 26/01/2016.
Very poor farmers	Only rainfed land or landless; no animals. If they have irrigated land, they may not have capital to produce and lease the land. No oxen; no farming tools. Work as labour. Some are supported by government with irrigated communal land. Many female-headed households, in particular elders, mentioned in this group. Probably receive food aid.	*'Those poor farmers face problems of not having initial capital for seeds, labour and fertilisers. Also, they're lazy farmers, their farms have weeds.'* Male WC members, WUA, lowlands [E_Wa-G-01] 30/01/2016. *'This land [an irrigated communal farm] is not enough for all, we hardly feed our families. But we don't have any other option. For the time being it is OK. Some of the members were in Saudi Arabia. It's better here'.* WUA leader, lowlands (male) [E_Tsi-ID-01] 25/01/2016.

Source: Typology generated from in-depth interviews and FGDs in Tigray (2016; 2018).

[137] Chat (*Catha edulis*) is a plant native from the Horn of Africa and the Arabian Peninsula used as stimulant due to its alkaloid content relate to amphetamines. It is commonly cultivated within Muslim communities in Ethiopia and broadly consumed (chewed) mainly by men. It is highly addictive. Source: WHO (2008).

Seemingly, in Mendoza, profitability appeared related to the amount of land cropped, which varied according to the cropping system, whether perennial or annual, and the farming techniques applied. Most of smallholders interviewed were managing their farms with a minimum use of inputs; old or already obsolete farming tools and equipment, and increasingly, minimum crop maintenance work. As a result, an increasing number of farmers must rely on non-agricultural incomes to make ends meet, most prominently perennial crop growers. Strikingly, 40% of all farmers surveyed were found depending on their retirement income to avoid selling their land.

(3) Degree of autonomy

A third outcome emerged from the methodological framework explores the autonomy of farmers, thus the 'bargaining power' (Agarwal, 1994, 1997) and 'agency' (Kabeer, 1999) to make economic and life decisions once irrigation water and the agricultural livelihoods are secured. Findings revealed that owning land and therefore water rights, particularly strengthened autonomy of women and other disadvantaged groups. In two FGDs in Tigray, women described how securing water rights through independent (irrigated) land rights had visibly improved their wellbeing; gaining economic independence help some women decide to leave abusive marriages[138]. In Mendoza, migrants from northern Argentina and Bolivia who used to work as seasonal informal daily labourers, had been able to settle and to provide education for their children by accessing irrigated land[139]. As irrigated agriculture helps secure more reliable incomes from farming, irrigation appeared allowing other disadvantaged groups a better life condition, such as elderly farmers of Tigray. For those farmers, agriculture represents the only option to receive an income as they would not be employed elsewhere. Likewise, illustrative cases in Mendoza showed that by farming their parents' land, a young woman with a chronic illness and a young male with a mental disability were able to develop economically autonomous lives[140].

---

[138] FGD with female farmers, heads of household [E_Ka-G-02] 05/02/2016 and [E_Ka-G-03] 14/03/2018.

[139] Manager 2nd grade WUA, Mendoza River Basin (male) [A_3aM-ID-05] 28/07/2016; WUA leader Mendoza River Basin (male) [A_3aM-ID-07] 08/08/2016.

[140] FGD female farmers, Lower Tunuyán River Basin, perennial crops [A_Ti-G-08] 23/05/2017; FGD female farmers, Lower Tunuyán River Basin, annual crops [A_Ti-G-09] 31/05/2017.

(4) Adaptive strategies

Fourthly, an increasingly important governance outcome relates to the adaptive strategies that individuals and communities use to manage the prevailing condition of irrigation water scarcity. In this comprehensive governance analysis it is important to identify not only the gender and other social differences to access and use water, but also the issues related to the nature of water scarcity. Both in Mendoza and Tigray, the political discourses around water scarcity have been framed within the biophysical aspects of water and neglecting the social relations of power involved (Budds, 2008; Mehta et al., 2019). For instance, water scarcity in Mendoza has been portrayed as basically a matter of less irrigation water available due to less snowfall in the high mountains; therefore official adaptive strategies mostly look at reducing the use of water and improving hydraulic infrastructure (DGI, 2019)[141]. This overlooks, however, that irrigation water appears scarcer for small-scale farmers who are dependent on surface water distributed by communally maintained hydraulic infrastructure as revealed by fieldwork results. The current supply-based distribution system imposes the need to have access to an additional water source (groundwater) for crops that need more frequent irrigation such as vegetables. Mostly only affluent farmers that can afford drilling a deep well can access additional water (Hurlbert and Montana, 2015).

Farmers that produce within the subsistence level are constrained to rely on own practices that help manage water shortages. Informal agreements between farmers such as sharing or swapping the water allocation with neighbours were mentioned as the typical strategy used by smallholders to make water cover their crops needs. Informants from Mendoza[142] also indicated that they adapt their irrigation systems when the irrigation turn is less abundant; irrigation is done by the farm owner instead of hired labour to do it more efficiently. Other farmers used furrow irrigation when there were water shortages and flooding when water was abundant. In Tigray, water shortage due to unreliable rainfall, motivated an ambitious government programme of irrigation expansion with groundwater and pressurised irrigation systems (Yohannes et al., 2017). However, interviewed smallholders lacked the necessary skills for a cost-effective use of this very expensive pumped water. Overall, farmers

[141] DGI conference for WUAs [A_M-O-02] 28/04/2016; DGI technical seminar on water supply and demand [A_M-O-03] 04/05/2016.

[142] Interviews with DGI engineering officers (male) [A_M-Op-05] 26/04/2016; [A_M-Op-06] 28/04/2016 and Director of Engineering Department (male) [A_M-ID-12] 08/08/2016.

responded reducing their expenses, investing less in system maintenance or leaving farming. Therefore, wealthier farmers in both countries appear more able to respond to water shortages due to accessing more coping alternatives (Mehta, 2007). In contrast, those smallholders already constrained to secure water, farming livelihood strategies and autonomy, including many women, appeared less able to adapt and stay in the farming activity, leading to increasing inequalities in livelihood options from water use.

6.5. Implications for policy and practice

The analysis of these interrelated outcomes has presented a detailed account of the processes of gender differences and inequalities present in the Ethiopia and Argentina cases. The study provided empirical evidence from two very different countries around issues of gender identities, roles and relations in agriculture and irrigation, which is not common in contemporary gender studies. Those gender roles have a direct relationship with the extent of women's involvement in irrigation practice and management. The methodological framework used revealed three overarching policy-relevant contributions that will be discussed in the remaining of this section.

Gender-based constraints in irrigation persist despite the prominent role of gender equality and women empowerment within international development agendas

Applying the integrative methodological framework to Mendoza, an example of a technically robust and well-established democratic irrigation management system, and Tigray, an example of technically less developed irrigation schemes and more hierarchical governance system, this paper shows that gender-based constraints to access, participation and decision making by women persist. This happens in a context of ubiquitous call for gender equality and women empowerment within international development agendas. This study has been relevant to explain to what extent gender as a factor drives inequalities within the irrigation sectors when interacting with other complex factors such as technical management and system maintenance, especially when those issues are important sources of water shortages. These findings add to other scholarly accounts of environmental and physical matters of water access and use intersecting gender social relations (Harris et al., 2015; Thompson, 2016). The incorporation of the feminist political ecology approach to this framework helped make visible hierarchies of gender-based constraints in irrigation based on independent access to resources, age, status, and socio-economic background. Clear patterns of low participation of women in irrigation were common in both research locations and suggest the need for interventions that explicitly takes into account women's constraints in irrigation.

The study explored the question of how women were able to access irrigation water and at what cost. The key issue defining access to irrigation water is land ownership. Independent access to land and possession of land titles is still less common for women than for men in these two research locations. In Tigray, female farmers not personally holding water rights and in need of irrigation water are generally not prevented from accessing water informally as previously observed by Ebato and Van Koppen (2005) also in Ethiopia. However, informal water rights prevent less powerful farmers, including certain groups of women, from secure and reliable access to irrigation water. As shown by this study, these informal access mechanisms sometimes work and sometimes do not, which may affect women's autonomy as observed in the past (Zwarteveen and Meinzen-Dick, 2001). The study confirmed evidence justifying policy interventions that ensure independent property rights for women with impact on the policy sector and practice. For example, land registration policy reforms in Tigray were instrumental in allowing women to become independent members of WUAs. This has improved their access to irrigation water. In Mendoza, land rights for women are part of a strongly regulated property rights system, and entitle them to independent irrigation water rights. The fact that secured land right tenure can reduce women's vulnerability in cases of 'economic hardship, divorce, or widowhood' as well as 'strengthen their bargaining power within the household' (Lastarria-Cornhiel et al., 2014) seems to also be a powerful policy justification for interventions that secure independent water rights for women.

However, even in these two countries with official policies supporting women's land rights, and associated water rights, many women do not assert those rights due to specific gender-related constraints. Material inequalities appear affecting all small-scale farmers; however, women face additional problems. For example, economic power appears to be the most relevant mechanism for acquiring water rights in traditional irrigation systems in Bolivia (Mehta et al., 2012), Tanzania (Franks et al., 2013) and Bangladesh (Crow and Sultana, 2002). While this was not observed in this study, many women in Tigray and Mendoza, even when holding formal water rights were prevented from fully using those rights due to lack of capital to produce. Key informants reported that those women rent out their lands and leave the farming sector. In addition, local cultural practices still favour men who dominate the usufruct and decision-making over the economic value of water. Evidence from Mendoza indicated that a land title registered in a woman's name does not necessarily mean that she is the one who is farming and/or making the agricultural decisions. In the farms owned by women alone or jointly with a man, many of the farming decisions were made by husbands or male relatives; only in few cases were farming decisions made only by women. These findings clearly resonate with theorisations of access to natural resources mediated by the 'ability' rather than the legal property to access (Ribot and Peluso, 2003; Gimelli et al., 2018).

Findings from this study also add to the gender and social relations scholarship (Agarwal, 1997; Kabeer, 2011) explaining how processes of social differentiation influence peoples' decision making and autonomy. Results from this study confirm and explain why some groups of women were more constrained than others. For example, married women, in particular those at reproductive age, reported being more disadvantaged in regards to economic independence and decision making than, for example, female heads of households with access to land and the autonomy to make economic decisions. It has been suggested that those female-headed households may 'very successfully' secure subsistence and wellbeing (Momsen, 2010: 43). Many married women in rural Ethiopia lack independence and control over family resources and decisions, which in addition to restrictive social norms, greatly limits women's autonomy. In both Tigray and Mendoza, women with a higher involvement in farming played a larger part in household agricultural decisions. Realising this, a government programme of modernisation of agricultural machinery in Mendoza has implemented independent production activities led by the wives of the registered farming households (IDR, 2019a). Those women were able to work close to their homes, secure an income and expand their farming knowledge through training. Importantly, these independent activities allowed women to be registered as farmers and become eligible for social security benefits and financial services.

In both Tigray and Mendoza, women were found to have a low participation in irrigation systems management (Imburgia et al., unpublished manuscript-a) as it has been reported elsewhere (for example, Zwarteveen et al., 2010; Udas, 2014). Cultural practices and social norms still prevent many women from undertaking activities related to irrigation management. This imbalance in participation has practical implications for women, including the higher cost of irrigation, less consideration of women's needs, opinions in decision making, and considerably fewer opportunities to improve their farming and irrigation practices. This is not exceptional. Evidence from other locations also shows that women claiming participation in the male dominated sector of water governance have to confront culturally rooted ideologies and power structures, often at a personal cost (for example, Vera Delgado, 2005). The male dominance in irrigation administration and water policies appears to reinforce women's exclusion in water access and control (Chancellor, 2005). This issue may not only affect women farmers but also female irrigation professionals.

6.5.1. Irrigation agriculture– a driver of social differentiation?

Access to irrigated land appears to be critically important to overcome poverty for small-scale farmers in southern Tigray, as it has been observed in northern Tigray (Gebrehiwot et al., 2015). In the Raya Valley, the low diversification of incomes observed may be explained by farmers owning irrigated land and being relatively better-off than in areas of only rainfed agriculture. On the other hand, external liquidity seems to be a key factor in the irrigation system in Mendoza. In recent years, only those with capital seem to be able to enter the farming sector, provoking a progressive concentration of land and agricultural businesses in fewer holdings. Many farmers go bankrupt, lose their water rights and are obliged to sell their lands and leave agriculture. Only smallholders who can afford to 'subsidise' farming with off-farm income or with unpaid family labour can stay in the sector. In regards to women, they have today a relatively lower participation in the small-scale agricultural sector of Mendoza. This is partly explained by the current low profitability of farming (together with the high cost of living), which obliges men and women to search for jobs outside the home. Many women now favour less physically demanding jobs with more economic security, although it is more difficult for rural women to find appropriate jobs off-farm.

In both countries, securing one's own irrigation source (own borehole in Tigray or deep well in Mendoza) seems to better prepare farmers to adapt to climate variability and water distribution inefficiencies. This will probably widen the gap between richer and poorer farmers, and define which small-scale farmers are able to stay in the sector, what reinforces the call for explicit equality policy in infrastructure management and transparent discourses in water scarcity (Budds, 2008; Mehta et al., 2019). These implications have fundamental importance in view of the prevailing constraints to advance inclusion of disadvantaged vulnerable groups in sustainable development (UN-Women, 2018).

6.5.2. Irrigated agriculture as an empowering livelihood option for women?

However, today women play a much more visible and active role in agriculture in many developing countries. Outmigration of male labour in Latin America, Africa and South Asia, and war, civil conflicts and the HIV pandemic in Africa are important contributing factors. In both research locations, women were found having less off-farm income occupations than men to sustain livelihoods when agricultural incomes are reduced. Conversely, results revealed that small-scale irrigation is a central livelihood strategy for women with limited off-farm options provided water access is secure. Many rural women with primary family responsibilities, relatively less mobility than men, and lacking education and resources for entering other economic sectors, still find in agriculture a main source of employment. For example, a group of interviewed women in Mendoza has recently developed their own wine production line in an effort to have an independent livelihood diversification alternative to the very low returns realised in grape production.[143] Examples from Tigray also show that women with access to land and technology are able to independently sustain themselves and their families. A widowed woman in the highlands who inherited land from her husband and dug her own borehole was able to feed and provide education for six children through irrigated farming. In Wargba, in the lowlands, a divorced woman with half a hectare was able to raise four children, send the eldest to the university and open a shop for a daughter in town.[144] Thus, it might be considered that this representation and participation of women in agriculture is not necessarily the result of societal development towards more gender equity, but rather borne out of economic necessity. Nonetheless, evidence indicates that pertinent gender equality policies (when technically sound and responding to concrete farmers' needs) have a transformative potential, as demonstrated by the recent Ethiopian land policy distributing irrigated land to young single women and issuing land certificates in their names. This has increased the independent involvement of women in agriculture in a relatively short period of time. By contrast, in Mendoza, despite a much higher awareness of gender-based problems for rural women (in particular those related to domestic violence) than seen only a few years ago, neither the provincial agricultural office and its research and

[143] FGD with female farmers, Lower Tunuyán River, Mendoza [A_Ti-G-08] 23/05/2017.

[144] Open interview with female farmers, lowlands, Tigray [E_Wa-Op-04] 06/02/2016.

extension institutions, nor the provincial water office have specific gender equality policy frameworks in place.

6.6. Conclusion

By using an integrative gender-methodological approach, the study was able to identify clear gender differences in irrigation access and management in Argentina, where a well-established governance system is in place, and in Ethiopia, a country with a fairly advanced gender equality policy framework. Despite the obvious differences in both countries, similarities in those processes became evident. In both countries, women accessed less land than men and had less frequent formal membership in WUAs independent of men, despite the fact that these two countries have official policies supporting women's land rights and associated water rights. The article showed the critically important value of an integrative gender analysis to make gender inequalities visible in NRM studies. Despite decades of adoption of policy changes, women in farming remain constrain by similar factors including position in the household, marital status, age, and socio-cultural background. In both cases, structural inequalities mostly driven by social relations of power and material inequalities persist. Neverthelsess, the article shows that, provided water access is secured, irrigated agriculture is an empowering livelihood option for many rural women with limited off-farm options. Using empirical findings, the article reports a number of enabling factors to improve the quality of women's involvement in irrigation. Independent land rights, and therefore, water rights for women are key to facilitate women work in irrigation and independent membership in WUAs. This was undoubtedly evidenced by the land policy change in Ethiopia of the last five years. WUAs with flexibility to accommodate the needs of different irrigation groups, including women, seem to better secure water for its members and reduce inequalities. This article particularly contributes to reflect on the current risks of widening the gap between those farmers able to cope with unpredictable and recurrent water shortages because of their ability to secure an own irrigation water source. As findings from this study demonstrate, many rural women are more constrained to access alternative income sources and therefore, less able to adapt to water shortages and irrigation water distribution deficiencies.

In order to allow more women with more meaningful participation in irrigation, there is a need for changing the cultural tradition of considering irrigation as matters of male expertise and responsibility. Improving the income level of women in farming, strengthening their technical knowledge, improving their access to information and extension services, and devising policies to explicitly support small-scale agriculture are essential steps towards this goal. While this call has been voiced before, its explicit resonance in development programmes remains low. Gender integration policies, at present weak and scattered in the agricultural sector, and non-existent in the water management sector, are needed in Mendoza. In the last decade, the recognition of women's rights under the law has remarkably improved in Ethiopia. The country relies on a fairly advanced gender and equality policy framework. However, implementation and policy enforcement at regional and local levels remain constrained by weak institutional structures and prevalent customary rules mostly to the disadvantage of women. Towards this end, more work is needed to understand the individual and collective interests of women to participate, as well as the enabling conditions for involvement of women as leaders of water governance structures. Raising the number of women employed, while also addressing their capacity development needs can also help to collectively develop ways to increase the number of women in irrigation management and their effective participation.

7. Rural development and the role of water users' associations in overcoming inequalities and sustaining small-scale irrigation agriculture

This article has been submitted for review to the Journal Development and Change.
Authors: Imburgia, L., Osbahr, H. and Cardey, S.

Abstract

Worldwide, the viability of communal irrigation systems is one of the most critical and urgent issues for securing the rural livelihoods of large numbers of smallholders. Governments and donors continue to emphasise direct irrigation management responsibilities through water users' associations (WUA). However, the widespread creation of WUAs and their role in the self-governance of communal irrigation water resources has come under scrutiny because of questions of efficiency, equality and effective participation of users. This article empirically re-examines governance outcomes, livelihood processes and challenges to equality in the self-governance of irrigation systems under the current conditions of increased water supply variability and the severe economic crisis of small-scale agriculture. *How do local institutions of water management affect equality in access to water, participation and decision making of communally managed irrigation systems? In highly regulated water governance systems, what role do WUAs play in overcoming inequalities?* The article suggests answers to these questions from field studies in Ethiopia and Argentina. Using a novel integrative analytical framework for empirical data, the mechanisms that govern participation and equality in self-governance of communal water resources are examined to identify reasons for failures and success, and discuss policy implications and opportunities to overcome barriers to equality.

Keywords: small-scale irrigation, water users' associations, self-governance, equality, livelihoods, rural development, Argentina, Ethiopia.

7.1. Introduction

Water users' associations (WUA) are the core element of self-governance of communal irrigation water resources in most countries. The promotion of WUAs from the 1980s with the widespread decentralisation of irrigation management was largely driven by development donors, which sought to devolve management of irrigation systems from government level to farmers (Uphoff, 1986; Ostrom, 1993; Garces-Restrepo et al., 2007; Meinzen-Dick, 2007). Establishing WUAs became mandatory in the course of donor-financed irrigation development. However, because this process is often entirely driven by organisations outside of local communities, many WUAs have suffered from insufficient consideration of existing community governance and power-sharing structures. Critiques of this top-down approach are now well established and include inefficiency (Meinzen-Dick, 1997; 2007; Senanayake et al., 2015), incomplete users' participation (Muchara et al., 2014), and inequitable water delivery (Zwarteveen et al., 2010; Franks et al., 2013). However, research itself on WUAs has become a matter of debate. Serious methodological problems, such as a lack of representativeness have been alleged (Senanayake et al., 2015), calling into question the usefulness of such research for solid scientific backstopping of policy decisions to support WUAs. So-called depoliticised approaches that fail to effectively address inequalities in access and participation in irrigation management and rooted in social relations of power, have been identified as especially problematic (Dewan et al., 2014). There seems to be a clear and present mismatch between the urgent need to 'provide information' for donor programmes about irrigation management methods, and the complexity of irrigation management systems in practice, leading to research results that may not be robust enough to inform policy and implementation.

The foremost purpose of WUAs is to provide secure and equitable access to irrigation water for all members. There can be no doubt that improved access to agricultural water positively affects incomes and builds agricultural livelihoods and food security, especially for smallholder farmers (for example, Koppen et al., 2002; Namara et al., 2010; Sellamuttu et al., 2014; Gebrehiwot et al., 2015). In particular, benefits for female smallholders are reported (for example, Upadhyay et al., 2005 in Nepal; van Houweling et al., 2012 in Senegal; Imburgia et al., unpublished manuscript-c in Ethiopia and Argentina). Although the positive role of WUAs in improving access to agricultural water has been confirmed in case studies, the specific role that WUAs play in providing benefits to the livelihoods of their members needs more investigation. These livelihood processes include all livelihood activities, opportunities and interactions (Scoones, 2009) that are important to sustain the vital agricultural livelihood strategies and outcomes of smallholders (e.g., improved irrigation and crop production practices, product marketing, and building social capital and networking). Most studies have focused on the impact of irrigation management transfer on farm productivity and yields (for example, Gragasin et al., 2005; Bandyopadhyay et al., 2007). This perspective, however, is rather too narrowly focused to explain wider benefits. Those seeking to develop a more holistic research perspective have mostly studied cases where WUAs were the result of donor-funded projects and had limited influence in water allocation and management. Franks et al. (2013), for instance, documented the case of a small catchment in Tanzania, with traditional institutions overlapping with newly created WUAs as a result of irrigation decentralisation; despite the existence of those WUAs, irrigation management arrangements were basically dominated by a rather small powerful group of users with privileged access to water. In Ethiopia, Yami (2016) investigated the contextual institutional, socio-cultural and political challenges for small-scale irrigation projects in sustaining the livelihoods of irrigation water users in cases where donor-funded irrigation projects created WUAs. In this study, WUAs were found to be extremely weak institutions because the WUAs were created top-down and did not develop their by-laws and rules themselves. Furthermore, the farmers within these WUAs did not have the capacity to take over irrigation management responsibilities. While these examples create a focus on the effects of institutional arrangements of irrigation water on livelihoods, they present context-specific cases where WUAs have a limited role in water access and management because of weak or non-functional collective systems. It seems to remain unclear what the defining characteristics of functional WUAs that shape livelihood processes and the equitable involvement of their members are, when the aim is to promote sustainable rural development.

Against this background, we submit that the role that WUAs play in the viability of small-scale irrigation schemes, and consequently in rural development, needs more, and particularly more *integrative* and well-informed research. In the current context of rapidly increasing water supply problems and a severe profit crisis in small-scale agriculture in many locations, it is important to take another look at participatory outcomes of collective governance, livelihood processes and challenges to equality in the self-governance of irrigation systems. In this paper, we present the application of an integrative methodological approach (Imburgia, 2019)[145], which proved useful for analysing the intersections and relationships of the technical and gendered social relations aspects of small-scale irrigation systems (SSIS) when applied to the individual irrigated farm level (Imburgia et al.,

[145] Chapter 5.

unpublished manuscript-c)[146]. In this paper, this methodological approach will be applied at the WUA's scale to analyse complex, multi-dimensional interactions in the mechanics of WUAs. We hypothesise that formal and functional WUAs are fundamentally important (*conditio sine qua non*) for the survival of communal SSIS, if and when they increase equality in access, use and decision making for less powerful smallholders, particularly women.

The aim of this article is to empirically describe and understand the livelihood processes and challenges to equality in the self-governance of communal irrigation systems under current conditions of increased variability of water supply, a severe profit crisis of small-scale farming systems, rapid changes in socio-economic and environmental landscapes, and effects of diverse political interference. Under these extremely complex contexts, *how do local institutions of water management affect equality in access to water, participation and decision making of communally managed irrigation systems?* In highly regulated water resource management systems, as in Argentina and Ethiopia, *what role do WUAs play in overcoming barriers to equality and sustaining small-scale irrigated agriculture*? The study will suggest answers to these key questions by utilising data from multi-case cross-regional field studies. In the next sections, we present, first, a problem analysis of self-governance of communal SSIS in Northern Ethiopia and Central Argentina; second, a discussion of patterns and processes of self-governance and resulting equality issues in the intersection of farmer practices and collective management, and third, an analysis of the role and potential of WUAs in sustaining SSIS in an increasingly difficult environmental and socio-economic context for smallholders in irrigation agriculture.

7.2. Conceptualising outcomes of self-governed small-scale irrigation systems

Accessing and using communal irrigation water requires social organisation, which can manifest itself in multiple types of formal and informal water governance systems. WUAs are participatory entities legitimised as the local decision-making platforms for collective water resource management (Kemerink et al., 2013). The role of WUAs entails the management of water distribution planning and use, and conflict resolution. WUAs also serve to make formal water rights operational (Meinzen-Dick, 2014); they link higher level

[146] Chapter 6.

governance structures with local management entities, and often, they channel external resources to the community (for examples, see Zwarteveen et al., 2010; Yami, 2013; Ortega-Reig et al., 2017). The establishment of WUAs has become an accepted approach to operationalise decentralisation of water management, and has been explicitly promoted by international donors and many governments since the 1980s (Uphoff, 1986). There have been three central objectives for the WUAs: to improve the management of irrigation water, since prior approaches were perceived to be problematic, especially in developing countries; to lower public expenses in the sector; and to better involve farmers in management and decision making (Garces-Restrepo et al., 2007; Meinzen-Dick, 2007; Senanayake et al., 2015). However, assessments of the widespread creation of WUAs indicate a failure to deliver on the ground, especially failing in decentralisation and devolution, cost recovery and users' participation (Aarnoudse et al., 2018). This failure has been broadly attributed to excessive confidence of donors and policy makers in simplistic management solutions; yet, water governance is complex and highly context-specific (Meinzen-Dick, 2007; 2014; Senanayake et al., 2015). In response, scholars and policy makers have extensively analysed the functioning of WUAs from various sectorial perspectives. Examples include: property rights and access to water (Vermillion, 1999); water delivery, infrastructure and technical management of irrigation systems (Morabito et al., 1997); crop productivity (Gragasin et al., 2005); financial viability of WUAs and cost recovery (Kamara et al., 2002; Koç, 2007); participation of users (Yami, 2013; Muchara et al., 2014), and influence of institutional arrangements and governance systems (Suhardiman et al., 2014; Haileslassie et al., 2016). A systematic evaluation of 230 impact assessments[147] of irrigation management transfer (Senanayake et al., 2015) has made apparent the mixed results in efficacy, with a large number of cases (45%) not showing conclusive success or failure. What this evaluation undoubtedly shows are flaws in representativeness and method in most of the assessments, highlighting the challenges of operationalising the WUA model in practice.

Of particular importance for our study is the analysis of decentralisation and devolution in delivering social and gender equality. The connection between WUAs and equality has been examined, within the gender and water research field, focused on the water decentralisation policy agenda of the last three decades (Cleaver, 1998; Ahlers and Zwarteveen, 2009;

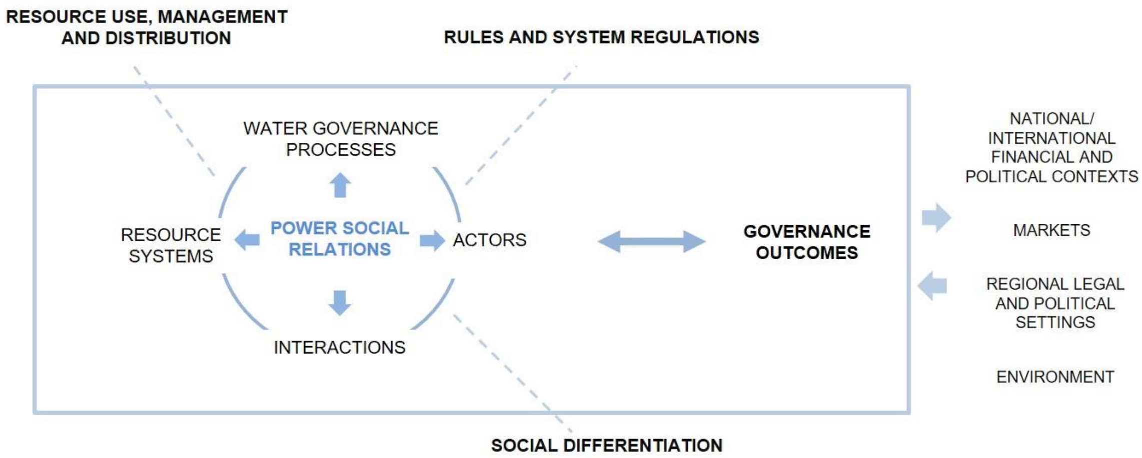
[147] This systematic evaluation involved 181 individual interventions of Irrigation Management Transfer and Participatory Irrigation Management collected from 131 papers (Senanayake et al., 2015).

Kulkarni, 2011). Existing personal differences between water users (i.e. gender, socio-economic and cultural background), and different water uses, interests and wealth within a community (Harris, 2015a; Sultana, 2015), are reflected in the dynamics of participation in WUAs (Masanyiwa et al., 2014; Mustafa et al., 2016). These differentiation processes shape who participates and how, with impact on the broader governance processes (Cleaver and Hamada, 2010). Increasingly, demands to 're-politicise' water issues have emerged from debates about water justice (Joy et al., 2014) and equality, most recently reflected in the 2019 UN-Water theme 'leaving no one behind' (UN-Water, 2019).

The integrative analytical approach applied in this study is based on three theoretical concepts: feminist political ecology; social-ecological systems and the social relations frameworks (Imburgia, 2019)[148]. In this paper, the analytical approach will be applied at the WUA's scale to analyse complex, multi-dimensional interactions in the mechanics of WUAs.

The application of the analytical approach as described in Figure 7.1, assumes that WUAs rule the way farmers, water management leaders and operators, and extension officials (i.e., key actors involved in the command area of an irrigation scheme) interact, use, manage and decide regarding common water resources (resource systems) and its management (water governance processes).

Figure 7.1 Summary of the integrative analytical approach



Source: Developed by the author based on Imburgia (2019).

148 For a detailed description of the development of this integrated approach, see Imburgia (2019).

The social relationships among actors produce dynamics of social relations of power that shape all interactions among the different elements; as a result, a number of overarching interactions emerge such as resource use, management and distribution; rules and system regulations; and social differentiation (Figure 7.1). By iteratively testing the theoretical approach with empirical data, Imburgia (2019) identified four key outcomes that synthesise the core elements of the functioning of the irrigation governance system: security of access, security of livelihood strategies, autonomy and adaptive strategies.

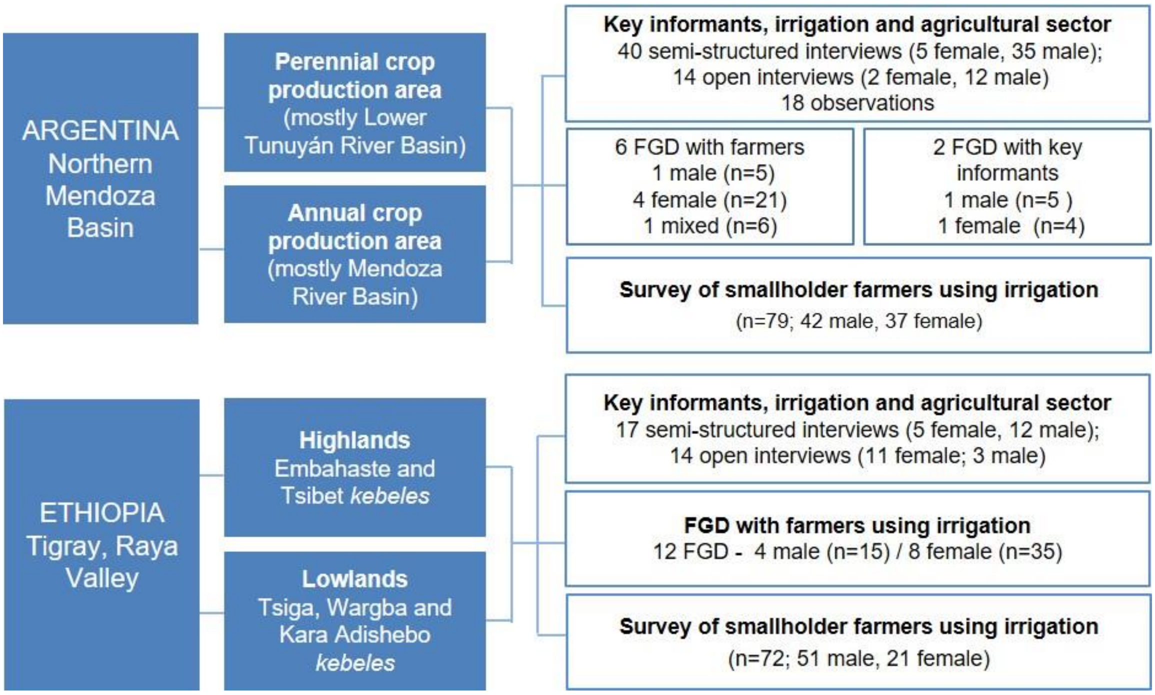
By applying a social relations perspective (Kabeer, 1999) to the analysis of the WUA's model of self-governance, differences and inequalities based on gender and/or other intersecting social differences (e.g. class, age, and socio-cultural background) (Harris et al., 2015; Thompson, 2016) become visible; their analysis and consideration help devise policy towards the improvement of those inequalities.

Specifically, the analysis of outcomes in irrigation governance systems of Mendoza and Tigray will help explain the extent to which changing patterns of participation and decision making due to, for example, decentralisation, influence equality in water access and management. This issue is the focus for the analysis.

7.3. Research approach and study context

The article uses data from a broader study on livelihood processes and gender participation in water governance in Mendoza and Tigray (Imburgia, 2019; Imburgia et al., unpublished manuscript-c) collected during 2016-2018. The unit of analysis used in this paper is the WUA. To allow diversity in the study of SSIS governance, a well-developed irrigation context in a mid-income country, Argentina, and a less developed irrigation context in a low-income country, Ethiopia, were selected. Additional selection criteria included significant numbers of smallholder farmers in the WUAs, and some degree of water shortage. The sites selected provided enough variability of collective water management by WUAs. A mixed-method research approach was used (Figure 7.2 below), which included a stratified, cross-sectional survey, composed of female and male smallholders using communal irrigation schemes and being organised in WUAs; in-depth individual and group interviews to key male and female informants (e.g. farmers, central water agency officials, and irrigation and agricultural experts), and participatory observations. The survey stratification included WUAs in areas with predominant use of surface irrigation water, and areas with complementary use of groundwater in each study location. The WUAs and the relevant key informants interviewed were purposively selected to cover a broad diversity of cases, views and opinions.

Figure 7.2 Study locations in Argentina and Ethiopia including sampling approach



Source: Field data collection for this study[149].

7.4. Resource systems, actors and water governance in the study sites

Mendoza province, centre-west Argentina

The Northern Mendoza Basin is an arid area that depends on irrigation for all its agriculture. Small-scale irrigation systems (SSIS) are the backbone of irrigation self-governance in Mendoza: 68% of irrigated plots have between 0.5 and 10 hectares (Imburgia, 2017). Survey respondents were smallholders growing mostly wine grapes, olives and plums in the perennial horticultural areas, and vegetables in the annual horticultural areas. Most

---

149 For anonymity of respondents, the following identification coding system was used: a reference letter for the country (‘E’, Ethiopia; ‘A’, Argentina), research site location within country, type of research tool used ‘S’, survey; ‘G’, group interview; ‘ID’, semi-structured in-depth interview (individual); ‘Op’, open interview (individual), and ‘O’, observation) and an interview order number. For example, for Argentina, the third survey conducted in the Lower Tunuyán River Basin in Mendoza Province is indicated as [A_TiM-S-03].

respondents used basic agronomic practices with low rates of innovation and investments. Profitability of the agricultural sector has been negatively impacted by recurrent economic and political crises with high inflation, currency devaluation, and limited policy support to the small-scale farming sector.[150] These factors have exacerbated the negative effects of a prolonged drought since 2005.

In Mendoza, the Water Resource Department (*Departamento General de Irrigación*, DGI) is responsible for devising and executing provincial irrigation policies. The operational management of the irrigation system is further decentralised and organised in WUAs (*inspecciones de cauce*)[151], of which 67% are members of a higher-level association. WUAs are public, non-government bodies with autonomy and legal capacity to enforce policy that is related to surface water rights systems; issues related to groundwater, including granting licences are operated directly by the DGI (Hurlbert and Montana, 2015).

The hydraulic infrastructure of Mendoza follows a typical layout of main (primary canal), branch (secondary canals), and distribution canals (tertiary canals) up to field channels. Primary canals are maintained by DGI. Secondary and tertiary canals, and irrigation scheme drainages are maintained by the WUAs. An *inspector* (leader) leads WUAs with assistance from three to five members. WUA members democratically elect leaders. Each WUA hires one or more *tomero* (water guards) for water distribution to farm gates. About 85% of the conveyance and distribution systems in the Province consists of natural or compacted earthen open-air channels. Converting earthen channels into lined and pipe water distribution has been a management and budgetary priority for the provincial water administration in the last two decades[152] to improve distribution efficiency. Survey respondents were women and men smallholders from the nine WUAs described in Table 7.1.

---

[150] Source: Fieldwork results.

[151] Until 2018, the province had 142 WUAs. Source: Fieldwork 2016-2017; personal communications with newly appointed DGI General Director (June 2018).

[152] DGI former General Director (male) [A_M-Op-04] 26/04/2016; DGI Technical Director (male) [A_M-ID-14] 19/08/2016.

Table 7.1 WUAs included in the study from Mendoza and Lower Tunuyán River Basins

River	WUA	Hectares of private agricultural water users*	Nº of private agricultural water users (no duplicates)**	% women members	Gender of inspector
Mendoza River	Association: *Tercera Zona*				
	- Rufino Ortega	805	135	30	M
	- Canal Vertiente Corralitos Unif.	1,953	657	34	M
	- La Primavera-Pedregal	486	202	32	M
	- Nueva Sánchez	994	364	32	M
Lower Tunuyán River	Association: *Canal Independencia*				
	- Canal Matriz Chimbas	3662	409	28	M
	- Cruz Bodega	890	103	33	M
	- Henriquez	450	46	28	M
	- Godoy	909	95	30	M
	- Sauce	1875	112	34	M

Source: Data from water distribution list, DGI databases. Date accessed 24/10/2016; elaborated by author. (*) With maximum of one year of water service fees unpaid; (**) Names of landowners having more than one plot registered were counted only once. Water users registered as private enterprises were not considered; (M) male

Tigray, northern Ethiopia

Tigray has an agriculture-dependent economy; about 80% of the population is rural and agriculture and livestock production are the most important livelihood strategies. The climate of the study area Raya Valley is semi-arid; the bimodal rainfall is relatively erratic and unpredictable (WWDSE, 2015). Irrigation expansion has been adopted as the most important strategy to fight poverty and food insecurity (Gebrehiwot et al., 2015). While the overall water resource administration falls under the Ministry of Water, Irrigation and Energy (MWIE), the water resource management remains under the jurisdiction of the regional and lower level water administration in correspondence with the administrative boundaries: zone, *woreda* (district) and *kebele* (sub-district). At the local level, the Agriculture Bureau administers irrigation water and supports the constitution of WUAs to operate the system. A water committee of 1 to 12 members, led by an *abomay* (water leader), represents each WUA.

In the study sites, different types of WUAs were found (Table 7.2 describes the selected WUAs for this study). In the highlands, all irrigation is done with surface water distributed through a number of communal hydraulic infrastructures. Most farmers use furrow irrigation. In the lowlands, where most irrigation is groundwater-dependant, farmers use both furrows and pressurised systems (drip and sprinklers). Existing information regarding groundwater replenishment and potential is limited; however, well drilling is proliferating (Hagos, 2010; Hailu Kahsay, 2018).

Table 7.2 WUAs included in the fieldwork for the study – Tigray, Ethiopia

Name of WUA	Kebele	Type[(a)]	Legality of WUAs[(b)]	Year of creation	Water source[(c)]	Irrigation systems[(d)]	Total members[(e)]	% women	Gender of abomay[(f)]
May ma'asile	Embahaste	V	R	2016*	S, CB	F	125	21	M
Ausehue	Embahaste	V	R	1991	S, CB	F	48	11	F
Chanty May	Tsbet	V	R	2001	S, EC, LC	F	86	13	M (2016); F (2018)
Geraf Lafi	Tsbet	V	R	2006*	R	F	33	6	M
No name	Tsbet	V	n-R	several years	CB	F	3	0	no authorities
Lemlem Wenale	Tsiga	V	R	2012	S, LC	F	82	3	M
Ra'e	Tsiga	V	R-AgCoop	2013	S, LC	F	54	13	M
Alem Wargba	Wargba	M	R	2009	1 DW	D&S	76	14	M
Lemlem Wargba	Wargba	M	R	2013	1 DW	F	65	8	M
Ma' kadawa	Kara Adishebo	M	R	2004	3 DW	D&S	194	39	M

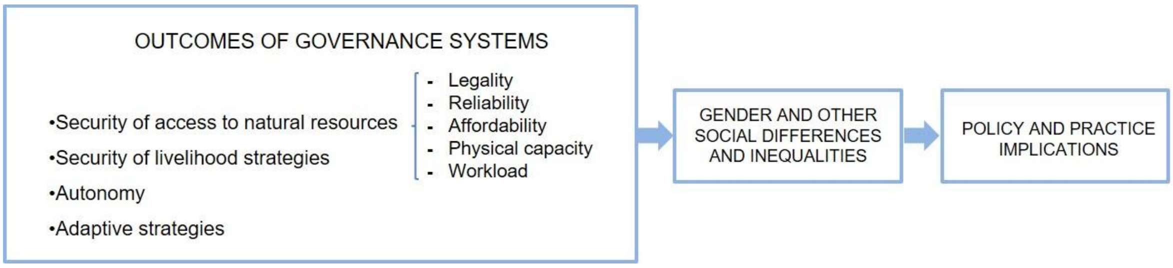
Source: Fieldwork in Tigray, January-February 2016; March 2018. (*) WUAs informally operating since the late 1970s.
(a) Type of WUA according to 2014 Proclamation, V: voluntary; M: mandatory.
(b) R: Registered or n-R: non-registered in the local government office (*kebele*); R-AgCoop: Registered as agricultural cooperative
(c) S: spring; R: river, CR: communal reservoir; CB: communal borehole; DW: deep well; EC: earthen channel; LC: lined channel
(d) F: furrow irrigation, D&S: drip and sprinkle irrigation
(e) According to interviews to key informants for this study (2016-2018)
(f) F: female, M: male

Survey respondents of Tigray were small-scale farmers producing in traditional or modernised irrigation schemes and organised in WUAs; all received income from crop production, and 65% of the male-headed households and 40% of the female-headed households also had incomes from livestock. Surveyed women and men farmers grew similar crops, which were mostly cereals and pulses for household use with a surplus for the market; and vegetables, fruits and pulses for the market. Farming was based on traditional low input agricultural techniques. Surveyed participants accessed insufficient and poorly equipped extension personnel, and produced with low profit margins.

7.5. Examining outcomes and linkages to equality in irrigation water governance

By applying the integrative-analytical framework, the four interrelated outcomes that synthesise the core elements of the communal SSIS governance (see Figure 7.3): (a) security of access to resources, (b) security of livelihoods strategies, (c) autonomy and (d) adaptive strategies are used to organise findings. As detailed in Figure 7.3, the degree of security of access to irrigation water by membership in WUAs is mostly related to the legal framework for property laws and entitlements, and the WUAs' rules and regulations; the reliability and affordability of the resource; the physical and technical capacity to access the resource, and the workload of users (at individual and communal levels). The remaining outcomes: security of livelihoods strategies, autonomy and adaptive strategies, resulting from the functioning of WUAs, further determine conditions and viability of the irrigation systems under increasingly complex management contexts.

Figure 7.3 Outcomes resulting from the application of the integrative analytical approach to irrigation governance systems



Source: Developed by the author.

So organizing findings allows focusing on the most critical aspects regarding how WUAs (under the decentralisation conditions of each research site) affect equality in access to water, participation, and decision-making. Findings illustrating each study location are presented separately below, to be jointly analysed in the next section.

7.5.1. The case of Mendoza

The degree of security of access to irrigation water by membership in WUAs is mostly related to the legal framework for property laws and entitlements, and the WUAs' rules and regulations; the reliability and affordability of the resource; the physical and technical capacity to access the resource, and the workload of users (at individual and communal levels) (Imburgia et al., unpublished manuscript-c) as it will be illustrated below.

In Mendoza, self-governance through the participation of water users has acquired a robust legal framework after a century of trials and errors. This provides a unique source of security of access to the water right holders. The Province Water Law (of 1884 and ratified by the Province Constitution of 1916) (Pinto et al., 2006) stipulates that formal water rights are inherent to land rights and are realised through mandatory participation in the WUA (Marre, 2007). In terms of land access equality, Imburgia et al. (unpublished manuscript-c) found that in Mendoza women had less independent land rights than men and therefore, less independent membership in WUAs. This makes gender asymmetries in access to water and decision making power apparent despite egalitarian inheritance right frameworks prevalent in Argentina.

The Province Water Law also stipulates different types of agricultural water rights that define diverse security of access. For example, a farm with a 'definitive' (perpetual) water right will be first in priority of water delivery and will always receive whatever amount of water is available for irrigation in a given season; farms with 'temporary' or 'precarious' water rights, instead, will receive water only when there is a surplus during the spring and summer seasons.[153]

The managerial capacity of WUAs impacts in two key aspects of security of access: reliability and affordability. Although a water right can only be lost with the loss of the land rights or by not using the right for five consecutive years (Pinto et al., 2006), WUAs are allowed to interrupt water delivery to a right holder due to unpaid water fees over one year[154]. Those WUAs able to successfully enforce this policy were found being able to maintain their financial viability and invest in infrastructure improvement. In contrast, those WUAs with poor capacity to claim water payments and to enforce sanctions had serious financial sustainability problems and therefore had become dependent on governmental support.

Reliable access to water is challenged by infrastructure deficiencies at all levels of the water distribution. The most common are canal obstructions by garbage, broken floodgates, and not properly cleaned or damaged canals. Observations from the WUAs' assemblies in Mendoza[155], showed that the lack of reliable access to water increased the number of

[153] Interview with DGI Legal Director (male) [A_M-Op-07] 12/05/2016.

[154] DGI Director of Finance (male) [A_M-ID-02] 25/04/2016.

[155] Participation of researcher as observer in 15 WUAs assemblies during 2016.

complaints from farmers. In many cases, water users showed their disappointment by delaying irrigation fees payment (Table 7.3). Thus, affordability (understood as the financial viability of WUAs), is challenged by difficulties to collect water fees. In addition, when WUA leaders are unaccountable to farmers, collecting water charges is also problematic. This poses managerial and financial pressure on WUAs, as the entire provincial water administration is sustained by the financial contribution of users. The solidarity principle underlying the provincial water management system ensures overall functionality by distributing income from water use fees to those WUAs in need. However, key informants raised the question whether this arrangement indeed contributes to long-term equitability.

Table 7.3 Level of satisfaction of water users with WUA's performance and payment of water fees - Mendoza

WUA	% Water fee collected by WUAs*	Level of satisfaction of surveyed water users (% of respondents**)				
		Excellent	Good	Average	Low	Doesn't know
Hijuela Nva. Sánchez	52	0	43	14	43	0
Rufino Ortega	83	80	20	0	0	0
La Primavera - Pedregal	50.25	25	50	25	0	0
Vertientes Corralitos	54.31	10	50	20	0	20
Rama Chimbas	68	0	43	21	14	21
Cruz Bodega	69.65	0	67	33	0	0
Sauce	65	12.5	87.5	0	0	0
Godoy	52	0	75	25	0	0
Henríquez	75	0	33	33	33	0

Source: (*) Data obtained from water distribution list provided by DGI. Date accessed: 24/10/2016. (**) Data regarding level of satisfaction indicated by surveyed farmers for the current research (2016). Author's elaboration.

Findings further revealed that the physical (including technical) capacity and workload required to maintain hydraulic infrastructure and therefore deliver water according to schedule may be challenged by political interference and power relations between the water agency and the WUA. For example, maintenance of the secondary water distribution systems requires the use of heavy machinery belonging to and managed by the central water office. WUAs must request turns for using this machinery. Informants from WUAs reported cases of unequal distribution of those turns according to how close or distant the relationships between officials and WUAs are. Often, agreements on the use of the machinery are a result of strong negotiations and conflicts. The location of new hydraulic infrastructure or financial support to improve existing infrastructure was said to be highly influenced by the good relationships of the WUA leader with the decision makers or certain political agenda of the central water management, according to key informant interviews[156]. Depending on the ruling party in public administration of the Province, those agreements may or may not respond to a water management need, or pursue an equal distribution of public resources. This clearly implies that equality is at risk when political influence is not fair and not transparent. It is worth noting that in Mendoza, the highest authority of DGI is designated by the provincial governor, and must be an affiliate of the ruling political party. Therefore, political changes at the government level have a direct effect on the leadership of the provincial water resource management.

When such managerial issues have an influence on a timely and reliable water distribution, smallholders and farmers without strong power in the WUA are affected most. The case of one WUA from the Lower Tunuyán River Basin illustrate this matter. Surveyed wine grape growers[157] complained that the gaps between water turns were too large (every 21 days), which was insufficient at end of spring and summer seasons. Another group of women farmers[158] expressed disappointment because the WUA leader told them to stop growing vegetables (their sole source of income) when they requested a more frequent water turn, necessary for their seasonal crops. When those issues were discussed with key informants from the water administration[159], they explained that water distribution frequency did not necessarily respond to a poor water supply but rather to deficiencies in the WUA's management. In the majority of cases, smallholders do not have the financial capacity to invest in improved irrigation systems or in complementary water sources, such as drilling a deep well or constructing a water reservoir, commonly only accessible to large commercial agro-business companies (Imburgia et al., unpublished manuscript-c).

[156] Interviews with DGI Director of Finance (male) [A_M-ID-02] 25/04/2016; DGI Planning Department officer (male) [A_M-ID-10] 04/08/2016; DGI Engineering Department Director (male) [A_M-ID-12] 08/08/2016; DGI Auditing Department Director (male) [A_M-ID-15] 19/08/2016; Manager of 2nd grade WUA, Mendoza River (male) [A_3aM-ID-05] 28/07/2016; Manager 2nd grade WUA, Lower Tunuyán River (male) [A_Ti-ID-19] 23/09/2016; DGI technical officer Lower Tunuyán River (male) [A_Ti-ID-20] 29/09/2016; WUA technical officer Lower Tunuyán River (male) [A_Ti-Op-02] 12/04/2016; various interviews to WUA leaders (male) [A_At-ID-23-26] 18/10/2016; DGI Delegate Diamante River (male) [A_Di-ID-37] 01/11/2016.

[157] Surveyed farmers, Lower Tunuyán River: female, 59 years old [A_TiM-S-2] 16/09/2016; male, 83 years old [A_TiM-S-06] 20/09/2016; male, 73 years old [A_TiM-S-06] 20/09/2016.

[158] FGD with women farmers, Lower Tunuyán River [A_Ti-G-09] 31/05/2017.

[159] DGI Delegate Lower Tunuyán River (male) [A_Ti-ID-21] 14/10/2016; DGI WUAs' Coordinator (male) [A_M-ID-13] 09/08/2016.

While a robust legal framework, effective performance of WUAs, proper enforcement of rules, and financial strength of the WUA are all factors that increase security of access to water for farmers, the success or failure of WUAs are strongly linked to the economic results of SSIS and the agricultural sector. Therefore, security of livelihoods as an outcome of the irrigation governance system contributes to the viability of WUAs and, iteratively, of the SSIS. This is clearly illustrated by the large number of water right holders that have withdrawn from the systems or do not pay the water fees due to failure of their farming business. These farmers are mostly smallholders; after a few years of not using their water rights they usually sell their lands to larger agricultural or real-estate investors (in peri-urban areas)[160]. For example, a WUA leader commented that, while five years ago his WUA in the Mendoza River Basin used to receive about ten requests of water rights withdrawal per year, by mid-2016 the requests grew to more than a hundred.[161] This highlights how farmers are leaving the sector and how WUAs are becoming more and more financially vulnerable; at present, most WUAs find it difficult to afford the irrigation management costs, as those costs have grown too high due to inflation and currency devaluation. At the same time, the net profit of the farming sector has decreased.

An important implication of the above considerations is that the technical and financial capacity of WUAs determine their degree of autonomy to lead local resource management and solve collective action problems. At the WUA's scale, autonomy is closely linked to two key issues: first, how the decentralisation and devolution processes have been implemented; and, second, the level of political influence that the irrigation sector has. In Mendoza, while by law, WUAs are decentralised water governance units, for decades, the participation of water users was to a large extent nominal with an increasingly centralised management by the DGI (since 1950) and a high concentration of power by wealthy land owners in irrigation areas[162] (Marre, 2007; 2010). From mid-1980s, a 're-decentralisation' process followed the global decentralisation agenda, with the objective of improving users' participation in the governance and administration of the water resource (Marre, 2007). Although

[160] DGI WUAs' Coordinator (male) [A_M-ID-13] 09/08/2016; DGI Mendoza River Delegate [A_M-ID-16] 29/08/2016; Manager of 2nd grade WUA, Mendoza River (male) [A_3aM-ID-05] 28/07/2016; WUA leader Mendoza River (male) [A_3aM-ID-06] 01/08/2016; WUA leader Mendoza River (female)[A_3aM-ID-39] 04/04/2019.

[161] WUA leader Mendoza River (male) [A_3aM-ID-06] 08/08/2016.

[162] DGI Technical Director (male) [A_M-ID-14] 19/08/2016.

decentralisation helped improve efficiency[163] and gain more autonomy -WUAs started to plan their own budgets and manage their funds directly- their technical, financial and overall decision-making autonomy resulted incomplete (Marre, 2010). This process unfolded unequally distributed across the Province. According to key informants[164], decentralisation in Mendoza resulted in WUAs of very different size, with unequal technical and managerial capacity to enforce rules and to collect water fees.

The political influence that the state exerts over WUAs not only affects autonomy of managerial decisions but also equality in rule enforcement. For example, fieldwork showed that the ability of WUA leaders to enforce sanctions on users for not paying the water fees was to some extent conditioned by the type of water user, i.e. *who* was not paying. WUA leaders interviewed[165] indicated that even though they made efforts to get paid, in some occasions, they were asked by the central office to continue delivering water to users with debts, particularly public entities. While in some cases this responded to 'social' criteria (for example, to avoid cancelling water to a school or public park), in other cases it was related to political 'favours'.

In a context of increasingly complex water crises due to water scarcity, climate variability, demographic and socio-economic changes, WUAs are constrained to use adaptive strategies that may affect their functioning and performance, but also help to ensure sustainability. In other words, adaptive strategies are an increasingly important outcome because WUAs have to cope with water shortages and continue delivering water to farmers so producers can maintain their farming incomes and in turn, pay for their water fees. The central water agency adjusts distribution of the available water proportionally to land size (Pinto, 2006); when there are water shortages, water is distributed in rotational turns instead of being continuously delivered[166]. While water turns were generally strict and well respected

[163] In the 1980s, there were more than 800 WUAs that progressively were unified. By 2016, the almost 100,000 water right holders existing in the Province became organised in only 142 WUAs. Source: Interview with DGI Director of Finance (male) [A_M-ID-02] 25/04/2016.

[164] DGI Director of Finance (male) [A_M-ID-02] 25/04/2016; DGI engineering officer (male) [A_M-Op-09] 29/04/2016; DGI WUAs' Coordinator (male) [A_M-ID-13] 09/08/2016; DGI Mendoza River Delegate (male) [A_M-ID-16] 29/08/2016; DGI Atuel River Council (male) [A_At-ID-17] 02/09/2016; DGI Lower Tunuyán River Delegate (male) [A_Ti-ID-21]; DGI Diamante River Delegate (male) [A_Di-ID-37] 01/11/2016; DGI Malargüe Irrigation Zone Delegate (male) [A_Ma-ID-38] 02/11/2016.

[165] WUA leader Upper Tunuyán River (male) [A_Ts-ID-33]; WUA leader Upper Tunuyán River (male) [A_Ts-ID-34]; Manager 2nd grade WUAs Mendoza River (male) [A_3aM-ID-05] 28/07/2016.

[166] DGI Technical Director (male) [A_M-ID-14] 19/08/2016.

throughout the area under analysis, in some less modernised WUAs, farmers attending WUAs' assemblies complained of receiving less water than in the past[167]. Since in these WUAs distribution deficiencies remained unresolved for years, farmers were found replacing crops, reducing the area planted or even selling or abandoning their farms.[168]

At the system level, the persistent drought of more than 10 years has led to the testing of diverse water-saving strategies that help reduce water distribution deficiencies and inequalities, for example, the construction of medium-size water reservoirs to store surface water destined to storage irrigation turns and re-distribute water to farms by means of pressurised pipelines[169]. Also, demand-driven water distribution is piloted in an on-line service in which farmers can register when they need water and the inspector and water guard organise water turns according to those demands in a more secured and systematic manner (DGI, 2018). At the river basin level, the Province of Mendoza has prioritised investments in diverse methods for canal lining and pipe distribution of water to reduce water losses and increase distribution efficiency.[170]

7.5.2. The case of Tigray

In Tigray, the water legislation also establishes right of access to irrigation water attached to land endorsements and proportional to land size; those rights to communal water sources either surface or groundwater are only realised by participation in WUAs (MWIE, 2000). In the highlands, indigenous informal and voluntary WUAs have existed for a long time (Habtu and Yoshinobu, 2006). The decentralisation of water resource management promoted the voluntary formalisation of new WUAs with mandatory participation of farmers within a command area when new irrigation infrastructure (e.g. diversion canals or water reservoirs) were constructed (MWIE, 2014).[171] In the lowlands research sites, the existing WUAs were

---

[167] WUA's assemblies: [A_3aM-O-07] 16/05/2016; [A_Ti-O-10] 20/10/2016; [A_Ti-O-11] 20/10/2016; [A_3aM-O-12] 21/10/2016.

[168] FGD male farmers Mendoza River [A_3aM-G-01] 30/08/2016; surveyed female farmer, 57 years old, perennial crop grower [A_3aM-S-10] 29/08/2016; WUA leader Mendoza River (male) [A_3aM-ID-07] 08/08/2016.

[169] WUA assembly Upper Tunuyán River [A_Ts-O-14] 26/10/2016.

[170] DGI Engineering officer (male) [A_M-Op-03] 19/04/2016; DGI Technical Director (male) [A_M-ID-14] 19/08/2016.

[171] For details see Water Resources Management Proclamation Nº 197/2000 (MWIE, 2000) and Irrigation WUAs' Proclamation Nº 841/2014 (MWIE, 2014).

formal, registered irrigation associations created to manage the groundwater use[172]; those WUAs were established by governmental programmes of irrigation expansion under the premises of management transfer and decentralisation since the 1990s (Gebrehiwot et al., 2015).

By applying the methodological approach, evidence showed that in Tigray the formalisation of WUAs and the decentralisation process resulted in mixed results. On the one hand, the formalisation of traditional WUAs into registered, legal entities seemed to have increased security and equality in access to irrigation water, in particular for farmers that used to be vulnerable and disadvantaged water users (usually elderly, persons with disabilities and many female-headed households) (Imburgia et al., unpublished manuscript-c). This was especially emphasised by women farming on their own. Participant women farmers[173] remarked that since the formalisation of the WUAs their access to water is not at risk, as it used to be in the past. Additionally, unfair water distribution to relatives or friends -also noted in the past (Yami, 2013) - were reported to have decreased. On the other hand, decentralisation in Tigray resulted in WUAs with very poor technical and financial capacity to assume responsibilities over a critically important and complex resource (Yami, 2016). Findings from our fieldwork indicated that after the construction of a hydraulic infrastructure (usually with the support of international projects) there is no budget provision for future maintenance, as also observed by Yami (2013). In the lowlands, for example, one WUA leader[174] reported challenges to repair electric pumps of the deep wells due to lack of technical capacity and unavailable spare parts.

In Tigray, like in Mendoza, reliability of access is tightly linked to the physical, technical and financial capacity of WUAs to afford the system maintenance (Imburgia et al., unpublished manuscript-c). For WUAs in the highlands, securing water access to members is physically more demanding and time consuming than in the lowlands, where WUAs access groundwater through modernised irrigation systems consisting of pipes, drip, and sprinklers. In the highlands, the characteristics of the terrain also demand permanent maintenance work to avoid sediments filling the irrigation channels. Hydraulic infrastructure

[172] Water Bureau Planning Director (male) [E_Mk-ID-01] 11/01/2016; Head of Agricultural Office, Raya Azebo *woreda* (male) [E_Mh-ID-01] 14/03/2018.

[173] FGD with female farmers, heads of household, highlands [E_Em-G-02] 13/03/2018; FGD female farmers, non-heads of household, highlands [E_Em-G-03] 15/03/2018.

[174] WUA leader (male) [E_ Wa-ID-03] 06/02/2016.

in these areas requires public investment in lining canals and waterproofing reservoirs. As leaders of highland WUA explained, farmers spend significant time and effort to keep canals cleaned.[175] Women who do not have the help of a male relative to perform this work, are forced to increase their farming costs in order to hire labour for canal cleaning. In the lowlands, irrigation practice is easier for all but technological (having the knowledge to maintain the pressurised systems) and financial (being able to afford the increased costs) constraints are still present.

Evidently, the success (and failure) of WUAs are strongly linked to the economic results of farming. Farmers indicated that the increasing cost of electricity to run the modernised pressurised irrigation system were in some WUAs exceeding farming profits. Therefore, some farmers had stopped farming.[176] This has a serious implication, as in Ethiopia, by law, if a farmer does not till the land, he/she risks to lose it. As a direct effect, if farmers cannot afford operation and management (O&M) costs, WUAs fail. Clearly, security of access to irrigation water, which transcends property rights, is a fundamentally important requisite to secure livelihood strategies in those SSIS.

In Tigray, management autonomy of WUAs is restricted to the water course or small irrigation scheme levels. By decentralising water resources, the government has substantially limited public involvement in O&M of irrigation schemes. However, this did not translate into more autonomy for WUAs. The hierarchical governmental interventions, especially in the modernised irrigation systems of the lowlands, dictate most water management decisions. For example, WUAs' by-laws, including water users' rights and responsibilities, are provided by the governmental offices[177], as also reported by Yami (2013). WUA leaders are requested by the agricultural office to control farmers' purchase of fertilisers (sold by the government who also sets the price) and application of improved farming practices with the mandate to interrupt water delivery for non-fulfillment[178] (Imburgia et al., unpublished manuscript-c). This governmental interference limits the participation of farmers in the

[175] FGD with WUA leaders (male), highlands [E-Tb-G-01 and 02] 03/02/82016.

[176] Agricultural officer, lowlands (male) [E_Wa-ID-03] 27/01/2016.

[177] WUA leader, lowlands (male) [E_Tsi-ID-02] 05/02/2016; Head of Agricultural Office, lowlands (male) [Mh-ID-01] 14/03/2018.

[178] Agricultural officer, lowlands (female) [E_ Ka-ID-02] 05/02/2016; WUA leader, lowlands (male) [E_ Wa-ID-03] 06/02/2016; Irrigation expert, highlands (female) [E_Em-Op-01] 02/02/2016; Irrigation expert, highlands (female) [E_Tb-Op-01] 04/02/2016.

design, operation and management of the system (Yami, 2013), and moreover, creates a constantly perceived risk of losing their water rights (and land tenure) through non-compliance. It also restricts the autonomy of WUAs, as described by Oates et al. (2017) for southern Tigray. These findings clearly suggest the need of mechanisms to limit such political interference.

Similar to the case of Mendoza, fieldwork in Tigray revealed critical contextual constraints for the sustainability of SSIS, and as a result, WUAs were found adjusting their management and farmers' support through a number of adaptive strategies. For example, in the highlands, those constraints include increasingly unpredictable rainfall; the shrinking of farm plots due to demographic growth; the low value of most crops grown, and newly established policies that drastically eliminate livestock from the rangelands as a measure to reduce erosion and sedimentation of irrigation channels. This increases the reliance of farmers on the success of crop production. In order to manage water shortages, farmers were found informally organising water turns according to crop needs, despite the official rule of supply-based water distribution. In addition, some WUAs of the lowlands established committees of irrigators to deal with economic and social issues and help sustain their livelihood activities (e.g., market, education, and savings). Unfortunately, and despite political influence on farming practice, WUAs receive poor technical support from agricultural offices on how to operate the modern irrigation systems, and to irrigate more efficiently. The issues illustrated above strongly suggest two key considerations: first, the need to integrate water management and agricultural strategies; and second, that the self-governance of SSIS transcends water problems. Therefore, the viability of SSIS demands WUAs with a broader scope.

7.6. Discussion

The findings have helped explained why the WUAs in both Mendoza and Tigray, and despite mixed results, are fundamentally important for the viability of communal small-scale irrigation schemes. Secure, reliable and affordable access to water is the economic foundation of SSIS as it is crucial for those who base their survival on the irrigation agriculture livelihood. In both research locations, smallholders organised in WUAs constitute the financial basis and social capital of the self-governance of water resource systems. However, in both places, water management decentralisation appears to be incomplete. Existing studies on decentralisation and self-governance of communal resources highlight the importance of genuine devolution of common property rights and decision making power, and where there are incomplete decentralisation processes, failures to sustainably manage common resources (Baland and Platteau, 1999; Agrawal and Ostrom, 2001), including irrigation water (Meinzen-Dick, 2007; Senanayake et al., 2015) result. Building on those studies, our research explains how strong legal frameworks; more transparent and fair enforcement of rules; equal distribution of resources among WUAs, and more equitable social relations and power share across the governance system result in stronger WUAs capable of a more efficient performance. This in turn, benefits vulnerable actors in the governance system, such as impoverished WUAs and smallholders.

7.6.1. Irrigation self-governance and equality: Enabling conditions for functional water users' associations

By applying the integrative-methodological approach for examining the interactions between irrigation sector actors, small-scale irrigation schemes, WUAs' rules and functioning, and the resulting outcomes (Figure 7.1), the study identified four enabling conditions that will strengthen the role of WUAs to support livelihood processes and equality:

(a) *WUAs supported by robust and stable legal frameworks, but with flexibility to accommodate the changing users' needs, are better equipped to secure water for members and reduce participation inequalities.* Both case study locations selected for this research offer good examples of how a 'clearly defined' and robust legal framework (Ostrom, 1993), appeared to increase the perception of equality among water users. In Mendoza, a robust participatory self-governance system has evolved through a century-long trial-and-error process. This now provides robust security to those with water rights, while preventing land and water concentration by powerful economic groups, as reported in conditions of weaker legal frameworks (for example, Franks et al., 2013; Kemerink et al., 2013). In Ethiopia, the legalisation of WUAs allowed the legal recognition of irrigation rights and obligations of less powerful water users, who now can claim their rights at official administrations. Furthermore, the formalisation of WUAs has brought stability and confidence to water users regarding their water rights, in particular those of vulnerable users (e.g., women farming on their own) as a parallel study revealed (Imburgia et al., unpublished manuscript-c)[179].

[179] Chapter 6.

Nevertheless, a robust and stable legal framework, although essential, is not enough to ensure equality. According to the results, equality seems to improve when the governance system in place also secures reliable and affordable access for all members.

(b) Regular maintenance of hydraulic infrastructure and water distribution, based on technical criteria, increase water security and equality. The results show that precarious systems to distribute water were found to decrease equality in access and ability to use the resource. By contrast, regular maintenance of hydraulic infrastructure and water distribution based on technical criteria increased water security and equality in particular for disadvantaged farmers (e.g., due to gender, economic status, or social position in the scheme). For example, in Mendoza, WUAs with a higher satisfactory performance (seen in Table 7.3) were active in cleaning canals, repairing the system and negotiating funds with the water agency for infrastructure improvement. Similar patterns were observed in the more precarious irrigation systems of Tigray. Major investments in reducing water losses through infrastructural improvement are obviously beneficial for all farmers; however, it explicitly benefited traditionally disadvantaged farmers. For example, women in the lowlands of Tigray appeared more involved in irrigation due to the implementation of pressurised irrigation systems (drip and sprinkler), which demand less physical effort for management and maintenance. In the last two decades, attention and resources invested in hydraulic infrastructure have shifted to a focus on the organisational aspects of irrigation (Aarnoudse et al., 2018). However, our findings from the cases in Mendoza and Tigray show that both aspects still require attention. This may be true in most developing countries where decentralisation resulted in the creation of WUAs with poor managerial skills to operate such a complex resource.

(c) Transparency and fairness in rule enforcement contribute to equality in the access and distribution of water, and help validate and strengthen the role of WUAs' leaders. The results show that more efficient, 'good performance' WUAs[180] are those that, in addition to organising an efficient water distribution, implement transparent management practices and equitable enforcement of rules and responsibilities. Scholars of the commons have explained this. According to Baland and Platteau (1999: 784): 'a greater measure of inefficiency in the use of the CPR [common public resource] will result from a higher degree of inequality'.

[180] Farmers in this study indicated that WUAs work satisfactorily when they can access their corresponding water timely, what allows them to produce.

This principle seems to apply even if the WUA have some (minor) management deficiencies, as confirmed in previous studies (Aarnoudse et al., 2018 in Sub-Saharan Africa). This is important considering that governance arrangements that enhance 'trust and reciprocity over time' appear better equipped to deal with complex resource management challenges because they are able to build social capital (Ostrom, 2011: 62). Interestingly, despite significant contextual differences between Mendoza and Tigray, our analytical framework showed that users in both systems responded similarly to increased fairness, transparency, and equality in WUAs' management. Improved fairness in irrigation management also brought about the positive response of WUAs' members in a similar case study in Japan, a far distant socio-cultural environment (Tanaka and Sato, 2005).

Equality in compliance of rules and responsibilities validates and strengthens the role of WUA leaders, as shown in Table 7.3 for the case of Mendoza. Conversely, farmers perceive problematic rule enforcement and failure to appropriately apply sanctions as sources of inequality. For example, in Mendoza many water users questioned those managerial faults by not attending to users' assemblies; reducing compliance with WUAs' rules (e.g. cleaning shared portion of canals), and by delaying the payment of water fees. This has a direct impact on the financial viability, physical capacity, and workload of the WUAs. In Tigray, although the fulfilment of WUAs' rules was mostly managed by coercion (if farmers do not comply, they must pay relatively high monetary sanctions and risk losing their right to farm and therefore their piece of land), findings confirmed that a more transparent and fair water distribution had increased equality in water access especially for vulnerable water users.

(d) Mechanisms to counteract political and asymmetrical power relations contribute to a more equal access, participation and representation in self-governance of irrigation systems. While traditional conceptions of common resource management institutions have considered water users as homogeneous groups (for example, Uphoff, 1986; Ostrom, 1993), in reality, the existing asymmetries in social interactions and power relations determine that not all relevant actors are represented appropriately in the governance systems and not all share decision-making power equally. When those inequalities risk access to irrigation water, vital for the survival of agricultural livelihoods' users, mechanisms counteracting power inequalities play a critically important role.

At the WUA level, this study found farmers effectively using their share of decision-making power to limit political interference and unfair power relations when electing WUAs' authorities. For example, although Argentina is characterised by a highly divided society of political opponents, water users of Mendoza rarely elect a WUA leader that represents a political party. Knowledge of the irrigation scheme and managerial skills tend to prevail in the voting decisions. Likewise, despite the political interference (and weak democracy) observed in Tigray (Yami, 2013), fieldwork interviews revealed that WUA leaders were selected according to their capabilities to solve collective irrigation problems and by being perceived as trustworthy by the community. Also, an implicit counteracting mechanism found in both study cases relates to the fact that farmers have low tolerance to corruption and mismanagement in issues related to the vital water resource. These examples corroborate the assertions that the severity and urgency of the resource management problem make water users select management pathways that offer more satisfactory solutions (Agarwal, 2015). An obvious assumption is that for this mechanism to be effective, a complete decentralisation process must ensure a genuinely democratic governance system (Agrawal and Ostrom, 2001).

All these four factors are critically important and must be in place; however, their effect on equality in governance of irrigation water remains unclear, when farmers cannot make a living from agriculture and risk losing their agricultural livelihood. Therefore, the next section discusses the role WUAs play in overcoming barriers to equality, taking into consideration that WUAs operate under extremely fragile economic conditions, as findings from this investigation revealed.

7.6.2. The role of WUAs in overcoming barriers to equality and sustaining small-scale irrigation agriculture

The relevance and urgency of the water resource define WUAs as institutions of a unique nature. The paper has provided empirical evidence showing how and why WUAs have a critically important role in improving equality in access to water and therefore in ensuring the survival of SSIS. These findings justify policies regarding WUAs as key elements of decentralised water resource management. However, results indicate that the way WUAs are conceived and equipped is not commensurate with the critically important role and the responsibilities they are demanded to assume: WUAs are usually technically and financially weak entities expected to effectively manage an extremely complex resource. Furthermore, WUAs are entities conceived to work in ideal, ‘depolitised’ contexts, in which all members are expected to share a similar amount of decision making power (Harris, 2008). This assumption, as already shown, clearly misrepresents reality.

The decentralisation of water management both in Mendoza and Tigray is sustained by WUAs that operate in extremely fragile conditions and mostly due to the goodwill of their members and leaders. Both in Mendoza and Tigray, WUAs are threatened by a series of factors and processes evolving due to demographic changes, political and economic instability, changes in land use, climate change and loss of profitability in the agricultural sector. Nonetheless, WUAs have a strong legal mandate and represent most irrigation water users in their localities. While in the case of Mendoza, all users of common irrigation sources must be members of WUAs, in Tigray, only smallholders using irrigated land are organised in WUAs. In addition, many resource poor, landless farmers and other vulnerable groups in Tigray have formed WUAs with governmental or international donor support. Imburgia et al. (unpublished manuscript-c) showed how irrigation is a key driver of social differentiation, and was of particular importance to sustain the livelihoods of rural women groups with limited off-farm income opportunities. This is especially the case when access to water is secured, reliable and affordable.

Findings have shown that farmers are able to develop strategies, although with certain limitations, that help solve individual production problems through their collective-action platform, the WUAs. For example, in Mendoza, in response to a prolonged drought (since 2005) a water agency programme (launched in 2015) offered WUAs the opportunity to assume leadership in infrastructure maintenance through a voluntary self-management O&M programme. In three years, the programme showed improvements (e.g., lining canals, earthen channels repaired, and installation of pipes for water distribution) that reduced water loses from infiltration and canal cleaning costs. In addition, inspectors who joint the programme indicated savings of up to 50% in comparison with hiring private engineering companies.[181] Some WUAs leaders were able to assume this responsibility successfully, while others did not. Those who did not join the programme was due to age (60% of the

[181] DGI Engineering Department Director (male) [A_M-ID-12] 08/08/2016; WUA leader, Lower Tunuyán River (male) [A_Ti-ID-18] 23/09/2016; WUA leader, Atuel River (male) [A_At-ID-29] 19/10/2016; WUA leader (female) [A_3aM-ID-39] 04/04/2019; WUA leader (male) [A_Ts-ID-30] 24/10/2016.

WUA leaders interviewed were in retirement age) or lack of managerial skills; others did not find enough incentives to increase their workload and responsibility[182].

In Tigray, while the functioning of WUAs showed mixed results (more equality and performance challenges), fieldwork showed that those involved in WUAs in the lowlands had improved their farming practices and to some extent, their access to the market and production information[183]. Interestingly, these conditions benefit women who are farming on their own. In this traditional society, where most women have restrictions to public life, including access to knowledge and technology, being a WUA member allows women to benefit from collective activities, and to gain access to technical and commercial information and farming inputs (Imburgia et al., unpublished manuscript-a) [184].

7.7. Conclusions

Applying a novel integrative analytical approach to NRM, the article examined the influence of WUAs on equality and agricultural livelihood processes under the serious and growing challenges of water scarcity and market, political, demographic, and environmental instabilities. In two diverse research locations similar patterns in the WUAs' performance and challenges to equality emerged. Decentralisation and devolution of irrigation management have been applied similarly worldwide. In both cases, inefficient water distribution and unfair practices in water governance are putting at risk the resilience of the SSIS. The novel analytical framework of the study helped identifying and understanding system-immanent interactions between social and technical dimensions. Social differences and inequalities, including those of gender, became transparent. Common patterns in the empirical results of this study across such diverse settings suggests the possibility of extrapolation of conclusions.

Our findings corroborate policy supporting WUAs as core element of water governance. However, WUAs, faced by serious and complex problems of the 21st century, still depend on management procedures and problem solving not appropriately adapted. The study identified four enabling conditions that will strengthen the role of WUAs to increase equality

[182] FGD WUA leaders (male) [A_Ti-G-02] 15/09/2016.

[183] Agricultural officer, lowlands (female) [E_ Ka-ID-02] 06/02/2016.

[184] Chapter 8.

and support livelihood processes. First, WUAs that rely on robust and stable legal frameworks, but have flexibility to accommodate the changing needs of users, are better equipped to secure water for members and reduce participation inequalities. Second, emphasis on the technical aspects of water distribution and regular maintenance and rehabilitation of irrigation systems are critical priorities in order to sustain equitable access to water. Third, transparent, fair and efficient rule enforcement mechanisms contribute to WUA users' willingness to meet their obligations. Fourth, the use of mechanisms that counteract unbalanced social relations of power improve perceptions of equality, increase users' compliance with rules and make WUA leaders more accountable to farmers.

However, even the successful resolution of performance and equality issues will not be sufficient to ensure the long-term sustainability of the water management systems. Our findings identified the need for two important policy revisions. First, WUAs should develop a broader mandate for the long-term viability of the organizations and the SSIS. Findings showed that WUAs have the potential to undertake complementary activities to support their service delivery and financial viability. In Mendoza, the WUAs' regulations allow for this broader mandate[185]. However, the political will to make the regulations operational is still pending. On the other hand, in Tigray most formal irrigation WUAs are not allowed to perform collective activities other than water distribution. Nevertheless, those that have more successfully integrated the water management with agricultural technical support have shown positive results. Interventions that support WUAs with the necessary elements to increase technical autonomy, to strengthen managerial and business skills, and to maintain collaborative work with the water administrations present opportunities for the state water sector and donor-funded projects.

Second, the overwhelming dependence of the water management system in Mendoza and Tigray on the agricultural sector calls for territorial development policies that integrate water management with serious efforts in the urgent revitalisation of agriculture. In Mendoza, political will is needed to enhance the value of small-scale agriculture as a critically important livelihood strategy, particularly amongst the youth who are massively leaving the agricultural sector. Also, critically important is the coordination of the different water rights

[185] In 2015, the DGI sanctioned a legal rule that allowed WUAs to develop activities other than those related to water management (e.g., production and services); incomes generated from those activities should be used in the functioning and maintenance of the irrigation scheme. Source: Resolución No. 370/2015, DGI (2015).

holders that are members of WUAs (i.e., urban, agricultural, recreational, and industrial water users, as well as energy producers and the mining sector) by establishing efficient participation approaches and incentives. In Tigray, expansion of the hydraulic infrastructure based on sound technical advice and bottom-up participation of WUAs from the on-set of projects is vital. There is also a fundamental need of an integrated effort to increase the value of the agricultural production while at the same time improve small-scale farming operations and productivity, cost-effective use of increasingly expensive inputs (including irrigation water), and enhancement of market access.

In both countries, not all actors directly or indirectly affecting and being affected by water resource management are represented in the governance systems. WUAs are the single local level institutions with the highest representation of irrigation farmers in the territory; however, a large number of women farmers, those who are not WUAs' members on their own right, are excluded from official decision-making spaces. Strengthening WUAs as catalysts of rural development seems to be both an important opportunity and an urgent need for the viability and survival of SSIS. This demands more inclusive mechanisms of participation with explicit support to the under-represented groups of users, particularly women. In addition, a broader stakeholder platform of discussion regarding the current and interconnected water challenges is needed in both governance systems.

8. Inclusive participation, self-governance and sustainability: Current challenges and opportunities for women in leadership of communal irrigation systems

This article has been submitted for review to the Journal Environment and Planning E: Nature and Space. Authors: Imburgia, L., Cardey, S., Osbahr, H. and Momsen, J.

Abstract

Genuine inclusive participation of women in the management of irrigation systems remains a challenge. This article analyses the gendered dynamics of participation in irrigation water users' associations (WUAs), drawing on cases from two diverse research locations in Ethiopia and Argentina. Findings suggest that despite large socio-economic and cultural differences between locations, women have more constraints in establishing equal access in membership, participation and decision making in irrigation management in both. The lack of inclusive participation and low representation of women in leadership roles lead to WUAs being poorly rooted in their community of users. The incomplete 'social rootedness' of WUAs jeopardises their effectiveness and equality in water management and, as a result, affects long-term sustainability. Through analysis of empirical data of small-scale irrigation systems in both countries, the article discusses who participates, how and why they participate, and the reasons for low numbers of women in leadership roles within the WUAs. Finally, the article reflects on possible enabling conditions that could foster inclusive participation, increase the quantity and capacity of women in management and leadership roles, and the transformative effect this may bring to sustainable irrigation systems.

Keywords: Inclusive participation, agricultural irrigation, water users' associations, women's leadership, social rootedness.

8.1. Introduction

Participation of users in irrigation water management has been adopted as the underlying principle of decentralisation processes in the irrigation water sector worldwide (Meinzen-Dick, 1997), and it has been particularly emphasised in neoliberal approaches to water governance (Ahlers and Zwarteveen, 2009; Harris, 2009). The necessity to include farmers within the decision-making process (to enhance local power and capacity to define their own rules and regulations in irrigation systems management), has been well-documented.

Participation has been used to explain enhanced efficiency, a sense of ownership of irrigation infrastructure, and financial and environmental sustainability (Tang and Ostrom, 1993; Ostrom, 2011; Senanayake et al., 2015). However, efforts to increase participation continue to produce mixed results in a range of different developing country contexts, both in the WASH (water for drinking, sanitation and hygiene) (Harris et al., 2015; Sultana, 2015; Adams et al., 2018), and agricultural irrigation water sectors (D'Exelle et al., 2012; Yami, 2013; Aarnoudse et al., 2018; Imburgia et al., unpublished manuscript-b).

From the 1980s, water users' associations (WUA) were adopted as the core institutions through which to operationalise participation in the process of decentralisation and devolution of communal irrigation management in many developing country contexts. Despite the existence of mixed results in effectiveness, there is evidence that WUAs have delivered effective management and improved access to water in some cases, and thereby led to improved food security and new opportunities in agricultural livelihoods for large numbers of small-scale farmers (Namara et al., 2010; Domènech, 2015; Senanayake et al., 2015). Moreover, WUAs can play a fundamentally important role for the survival of small-scale irrigation agriculture, ensuring - in some cases - equality in access and participation of less powerful, more vulnerable users, especially women (Imburgia et al., unpublished manuscript-b); however, obstacles to genuine inclusive participation in WUAs still remain. Most stem from the replication of unequal power relations that already exist among the community of users, in the functioning of the WUAs; the diverging interests of users not being appropriately addressed by WUAs leadership; an unequal share of decision-making power, particularly with vulnerable water users (including women) being excluded from this process; and incomplete decentralisation processes that lead to discrepancies between the perceived benefits of implementing a 'participatory model' and the realities in operating the WUAs in local contexts (Senanayake et al., 2015; Aarnoudse et al., 2018; Imburgia et al., unpublished manuscript-b).

The general debate of the equitable representation of women in governance and government has been the driving force behind sector policies aiming to strengthen the role of women in agriculture. However, mitigating unequal participation of women in irrigation water management remains a challenge (Lefore et al., 2017; Imburgia et al., unpublished manuscript-c). Despite being a topic for decades in gender and development debates, in many irrigated areas of the world, there is no there is no awareness of the need to strengthened the role of women; hence, WUAs continue to be male dominated at all levels

(Meinzen-Dick and Zwarteveen, 1998; Upadhyay, 2003; Bennett et al., 2005; Wallace and Coles, 2005; Zwarteveen et al., 2010), but especially in influential positions (Yami, 2013; Udas, 2014; Buisson et al., 2017).

Scholarship on women and irrigation water has tended to focus on the reasons why women are not equally represented in WUAs. However, to date the specific effects of increased women's participation and decision-making in local irrigation water governance, in particular when women occupy leadership positions, has not received commensurate attention. Not enough studies provide tangible examples of women leading irrigation WUAs to assess the changes that result in governance.[186] In other sectors, such as in community forest management, various case studies were able to draw on larger numbers of women participating in governance. These allowed the study the effects of enhanced female representation in NRM in a more quantitative manner (Agarwal, 2010; Agarwal, 2015). In the irrigation sector, behavioural experiments have been conducted as proxies to study the effect on equality of women managing the water resource (D'Exelle et al., 2012), comparing how women and men of low and high social status share communal self-governed irrigation water in conditions of water abundance and shortage. D'Exelle et al. (2012) found that women of high and low status tend to share more fairly than men, in conditions of water abundance. When water was scarce, men and women ensured first their own supply, however women were more inclined to fairness.

Against this background, this article considers whether improving the participation of women as independent members of WUAs, and in particular allowing more women to occupy leadership positions, would strengthen self-governance of communal irrigation, and provide a positive effect on the sustainability of small-scale irrigation systems (SSIS). The article aims to explore these issues by drawing on empirical evidence to elucidate the incomplete participation of water users in water management. Of specific interest is the question of whether low representation of women in management and leadership affects the rootedness of WUAs in their community of users.[187] This is important because the literature suggests that poorly socially rooted WUAs jeopardise effectiveness and equality of water

[186] For analyses of the specific issues of women in leadership of irrigation WUAs, see Van Koppen et al. (2001), for a case study from Nepal and Upadhyay (2003), for a review of cases from Nepal, India and South Africa.

[187] By 'well-rooted' WUAs this paper describes WUAs with greater representativeness of the members, and that are trusted and respected in the community of users; therefore, there is greater community ownership than in 'poorly-rooted' WUAs.

management and, as a result, the sustainability of the organisation. The paper specifically seeks to answer the following questions: (a) *what are the participation mechanisms of women and men in WUAs*; (b) *what are the reasons for low participation of women in leadership of WUAs,* and (c) *what are the opportunities and enabling conditions for increasing the involvement of women in water governance structures?*

This paper is organised as follows: first, it reviews relevant scholarship and presents an adapted participation typology to characterise forms of participation in the self-governance of small-scale irrigation schemes. This typology helps to describe the social interactions identified and how there may be different patterns of participation within different groups of men and women. Using empirical data from the participation of women and men in SSIS in Ethiopia and Argentina, the article reflects on the implications of the participation and decision-making patterns for the social rootedness of WUAs. Furthermore, the article discusses conditions for the active involvement of women in leadership roles, and the association of increased female leadership with sustainability of irrigation systems. Final reflections on policy and practice implications are provided.

8.2. Gender equality and participation in irrigation

Historically, barriers to participation, such as rules of entry, intrinsic social stratifications and customary norms have resulted in low participation of women in WUAs (for example in the Andes, as described by Bastidas, 2005; and in South Asia, as discussed by Meinzen-Dick and Zwarteveen, 1998). This happens even in those cases where women have a prominent role in agriculture and irrigation. For many rural women, structural inequalities are mainly driven by embedded social relations of power and material inequalities, which are difficult to overcome (Vera Delgado, 2005; Morales and Harris, 2014; Imburgia et al., unpublished manuscript-c). Socio-cultural and economic barriers prevent involvement in WUAs not only of women but also of other disadvantaged groups (Harris, 2006). These systemic inequalities are then reproduced in the participatory mechanisms used by resource management institutions (Morinville and Harris, 2014), especially when those mechanisms fail to consider the existing ‘intra-group’ social relations and power asymmetries (Agarwal, 2015) and the influence of contextual power dynamics on community organisations (Morales and Harris, 2014; Brisbois and de Loë, 2016).

Although the irrigation sector has been traditionally restricted to men in terms of practice, extension, leadership and education of irrigation (Zwarteveen, 2008; Ongsakul et al., 2012), increasing the participation of women in water resource management is critically important to address a broad range of development goals, including equality, social justice, adherence to democratic values (Cornwall and Edwards, 2015), and more rational design and implementation of water projects, as articulated within the Sustainable Development Goals (SDGs) (UNDP, 2019; UNESCO WWAP, 2019).

Identifying solely men as being in charge of irrigation water management can lead to inadequate water project design and planning due to the misrepresentation of women's role in agriculture, irrigation, access to information, and training for irrigation maintenance and governance (Cleaver, 1998; Momsen, 2010). However, exclusion of women from leadership roles in irrigation management has been seen as the social norm in many socio-cultural contexts. For instance, in a participatory soil conservation and irrigation project in the Andes in Peru, the exclusion of women from the project was assumed as a cultural norm (Vera Delgado, 2005). Here, the lack of land titles held by women and intra-household relations that limited women's public life were found to be the underlying reasons[188]. In Rajasthan in India, Raha et al. (2013) report on how traditionally, women have not been considered farmers in their own right, and consequently have not been fully included into watershed committees established to govern water and natural resources. This gender segregation is partly explained by male domination in the engineering and irrigation professions in many developing countries (for example Zwarteveen, 2011; Ongsakul et al., 2012) but also by male dominance in irrigation administration. This male overrepresentation in the irrigation sector reinforces female farmers' exclusion in irrigation management and that of female irrigation professionals in the design of the systems (Chancellor, 2005; Zwarteveen, 2011; Udas, 2014).

Development and water policies, sector irrigation institutions, and implementing organisations have invested in addressing these issues but yielded mixed results. Scholars have highlighted how some projects have led to a process of legitimising inclusive participation by women, especially initiatives set up by external international organisations.

---

188 Only household heads were called to consultations and most of them were men. Women were excluded from water user's organisations because they did not fulfil entrance requisites: land rights were in the name of men and therefore, water rights, too (Vera Delgado, 2005).

Examples are found in Bolivia (Mehta et al., 2012); and in other Andean countries (Boelens and Zwarteveen, 2002); as well as in Sri Lanka (Aladuwaka and Momsen, 2010) and in India (Raha et al., 2013). By contrast, Vera Delgado (2005) highlights the issue of external agents with often an incomplete understanding of local dynamics designing and implementing water projects that exacerbate the disadvantages for women and lead to a concentration of project benefits in few.

Existing differences between water users (i.e., gender, socio-economic and cultural background) explain differences in terms of water use, interests and resulting wealth within a community (Harris, 2015a; Sultana, 2015) and are reflected in the dynamics of participation in WUAs (Masanyiwa et al., 2014; Mustafa et al., 2016), thus, who is willing or allowed to participate, as well as why and to what degree.

In this paper, inclusive participation is understood as 'a voluntary process by which people, including the disadvantaged (i.e., by income, gender, socio-cultural background or education), influence or control the decisions that affect them.' (Saxena, 1998 reproduced in Cornwall 2011: 31). In this regard, the mechanisms of participation by water users will be determined here by: (a) inclusion and exclusion factors to the collective management; (b) the forms and levels of participation; and (c) interest in participating.

Inclusion and exclusion of women in water governance structures, as well as other community participation organisations, are shaped by four intertwined sets of factors: institutional governance factors; personal factors and attributes; the contextual dynamics of social relations, including gender relations (Sultana, 2009; Agarwal, 2010; Raha et al., 2013; Masanyiwa et al., 2014); and the complex and 'uneven' interactions (Collard et al., 2018) between physical characteristics of the resource ('nature') and society (Sultana, 2009). Agarwal (2001) suggests that more women would be empowered if they were included in more equitable numbers and through equitable forms of governance. This has been confirmed, for example, in irrigation systems in Tigray (Ethiopia) and Mendoza (Argentina), where the formalisation of WUAs and the implementation of clearer rules and regulations have helped many women to formally and independently access water, and as a result, rely on agriculture as a secured livelihood strategy of their choice (Imburgia et al., unpublished manuscript-c). In contrast, these institutions that are participatory by definition can exclude certain users due to structural factors (e.g., formal and informal rules of entry) and produce what Agarwal defines as 'participatory exclusions' (Agarwal, 2001). Such exclusions can worsen the condition of less advantaged women and other vulnerable irrigation water users.

The forms and level of participation of people in organisations has been usefully described by Agarwal (2001) as: nominal, passive, consultative, activity-specific, active, and interactive. According to this typology, participation is considered 'effective' if it goes beyond nominal participation, i.e., when members of an organisation attend meetings, have a voice, and influence decisions (Agarwal, 2001; 2010). Higher levels of participation described in this typology consider some social dynamics within the groups (e.g., which groups speak up in front of others) and outside (e.g., how cultural norms restrict women holding office positions). The analysis of these social dynamics is an entry point to understand the effect of social relations on participation outcomes (Agarwal, 2010).

The typology proposed by White (1996) describes participation according to the level of interest in participating: nominal, instrumental, representative and transformative. Each category is described by the top-down interest of organisations or projects; bottom-up interest of participants or beneficiaries of projects; and the function or instrumental use of participation. In practice, these forms overlap because the people involved will have a 'mix of interests which change over time' (White, 1996: 8). People's interest to participate, and the interest of those holding power, may not necessarily converge (White, 1996), and thus some degrees of participation do not necessarily imply challenging structurally-embedded local power relations.

To explore the mechanisms of participation of irrigation water users in water resource management, this paper adapts a typology (see Table 8.1 below) that includes elements of the Agarwal typology of participation and use these categories according to the degree in which participants exercise their rights and voice (Arnstein, 1969; Cornwall, 2003), and the degree of fulfilment of their shared responsibilities within the organisation. To make this typology relevant to irrigation management, water rights will be used as inclusion and exclusion factors. This adapted typology will also include leadership as a type of participation with transformative effects; that is, having the potential to 'empower' participants (White, 1996). The use of a typology to describe forms and levels of participation in water governance, which also reflects social relations, is useful in describing changing social interactions due to changing patterns of participation of different groups of men and women.

Table 8.1 Adapted typology of participation in irrigation self-governance according to rules of entry into WUAs

Rules of entry to WUAs	Type of participation	Characteristics of participants
Non-water right holder (non-registered member)	Non-authorised water user	Use of a communal water resource without agreement of community of users.
	Authorised water user	Operational right (Schlager and Ostrom, 1992) to use the resource, granted by family relationships, tenancy or sharecropping arrangements.
Water right holder (registered member)	Nominal	Water right owner; no exercise of collective rights and obligations.
	Minimum	Minimum exercise of collective rights and obligations to avoid losing the water right, e.g., payment of water fees.
	Passive	Limited exercise of collective rights and obligations, voice or influence in decisions is not guaranteed.
	Activity-specific	Partial exercise of collective rights and obligations; no official positions held.
	Interactive	Full exercise of collective rights and obligations, with influence on relevant decisions; hold management positions.
	Transformative (leadership)	Full exercise of collective rights and obligations; hold the leadership position with full decision-making power.

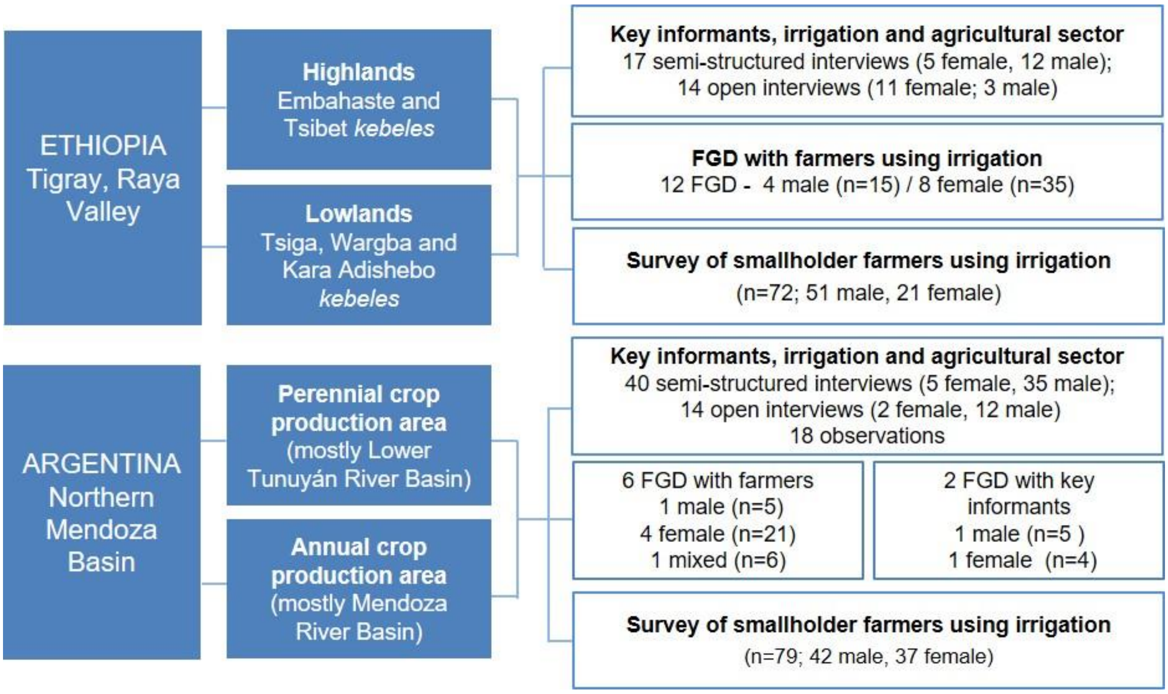
Source: Adapted by the author based on Agarwal (2010) and (White, 1996).

8.3. Methodology

To study how gender roles and relations in leadership of irrigation governance manifest in diverse contexts, the research selected a comparative trans-regional approach, which provides a high degree of physical and socio-cultural diversity. The data used in this paper were collected in Raya Valley in Tigray, northern Ethiopia, and northern Mendoza Basin, in Mendoza Province, centre-west Argentina between 2016 and 2018. These data were part of a larger study investigating the gendered outcomes and livelihood effects of irrigation governance (Imburgia et al., unpublished manuscript-c)[189] and the roles of WUAs in the sustainability of SSIS (Imburgia et al., unpublished manuscript-b)[190]. A diversity of evidence and methods was obtained through a multi-case mixed-method approach that included a stratified cross-sectional survey, focus group discussions (FGD), in-depth interviews and direct observations (Figure 8.1).

[189] Chapter 6
[190] Chapter 7

Figure 8.1 Study localities in Ethiopia and Argentina with sample size



Source: Developed by the authors.[191]

In both countries (Table 8.2), survey participants were male and female irrigation smallholders, members of WUAs. In-depth interviews were conducted with a purposeful sample of female and male informants, including farmers, WUA leaders, irrigation and agricultural experts, and water administration officials. Direct observations included participation in water management-related events and water users' assemblies. Data were evaluated using coding and thematic analysis for the qualitative data, and descriptive statistics for the quantitative data. The dynamics of social relations in water governance were explored by applying an integrative gender-analytical framework developed for this study (Imburgia, 2019)[192]. Results were analysed in each study context and, then, were subsequently jointly interpreted.

---

[191] For anonymity of respondents, an identification coding system was used: reference letters for the country ('E', Ethiopia; 'A', Argentina), research site location, and research tool used ('S', survey; 'G', FGD; 'ID', semi-structured in-depth interview (individual); 'Op', open interview, and 'O', observation), and an interview order number. For example, for Ethiopia, the first survey conducted in Embahaste *kebele* is indicated as [E_Em_S-01].

[192] Chapter 5

Table 8.2 Characterisation of the survey respondents of Tigray and Mendoza

Characterisation of survey respondents	Tigray		Mendoza	
	Male	**Female**	**Male**	**Female**
Average age total (n)	40.5 (50)	39.5 (21)	53.2 (42)	46.8 (37)
% Marital status (n)				
Married	96.1 (49)	19 (4)	83.3 (35)	83.8 (31)
Single	2 (1)	19 (4)	7.1 (3)	5.4 (2)
Widowed	0	23.8 (5)	2.4 (1)	5.4 (2)
Divorced	0	38.1 (8)	7.1 (3)	5.4 (2)
No answer	2 (1)	0	0	0
% Household type (n)				
Male-headed household	98 (50)	19 (4)	81 (34)	43.7 (16)
Female-headed household	0	81 (17)	0 (0)	17.1 (6)
Dual household	0	0	19 (8)	35.1 (13)
No answer	2 (1)	0	0	5.4 (2)
% Education level (n)				
No education	33.3 (17)	81.0 (17)	0	0
Primary incomplete	41.2 (21)	14.3 (3)	19 (8)	29.7 (11)
Primary complete	11.8 (6)	4.8 (1)	33.3 (14)	45.9 (17)
Secondary	5.9 (3)	0	23.8 (10)	10.8 (4)
Technical/Vocational	2.0 (1)	0	7.1 (3)	0
Higher education	0	0	14.3 (6)	8.1 (3)
No answer	5.9 (3)	0	2.4 (1)	5.4 (2)
% Cultural background of survey respondents (n)	**Tigray**		**Mendoza**	
	Highlands	**Lowlands**	**Perennial crops**	**Annual crops**
Tigrayans	100 (28)	100 (44)		
Criollos[*]			96 (43)	56 (19)
Norteños[**]			2 (1)	26.5 (9)
Migrants from Bolivia			2 (1)	18 (6)
Average household size total (n)	4. 79 (28)	4.77 (43)	3.32 (44)	4.44 (34)

Source: Survey of farmers. (*) born in Mendoza and of European origin); (**) migrants from northern Argentina.

Study sites: Context for participation in WUAs in Tigray and Mendoza

Tigray is one of the poorest regions in Ethiopia, with an agricultural-dependent economy. Raya Valley, in southern Tigray, has a semi-arid climate with a bimodal rainfall pattern; as rainfall is erratic and insufficient to sustain the farming livelihoods, supplementary irrigation has traditionally been a common practice in the area (Yazew et al., 2010). In the last two decades, the expansion of irrigated agriculture has been supported by governmental and international cooperation programmes to improve food security (Gebrehiwot et al., 2015); this effort has included the modernisation of irrigation systems and rapid growth of groundwater use for irrigation.

All the survey respondents from Tigray (see Table 8.2) were small-scale landowners. Farmers obtained incomes from crop sales, supplemented by livestock incomes. Men and women were found growing similar crops and therefore having similar irrigation water needs. In the irrigated plots, surveyed farmers mostly grew vegetables, cereals, pulses and fruits; in the rainfed plots, farmers grew cereals and pulses. All farmers interviewed used traditional low input farming practices and produced within very low margins of profit. In the highlands, all irrigation water used is surface water, distributed and accessed through a variety of hydraulic infrastructure, including shallow boreholes, hand-dug wells, earthen and lined channels, and water reservoirs. In the lowlands, farmers use groundwater for irrigation lifted by electric pumps and distributed by furrows and pressurised irrigation systems (sprinkle and drip). Small-scale irrigation schemes are managed through a variety of formal and informal WUAs[193], i.e., formal irrigation WUAs registered in the water offices, irrigation cooperatives registered in the agricultural offices, and informal, non-registered WUAs. In the highlands, registration of WUAs to manage surface water was found to be voluntary; once a WUA is established, however, anybody who wants to irrigate land in the command area of the organisation must become a member. In the lowlands, the groundwater (drafted from deep wells constructed by the government and collectively managed by users), was only accessible by compulsory membership in the corresponding WUAs.

Community activities are strongly rooted in the rural communities of Tigray. People are accustomed to supporting each other through informal organisations, typically related to savings, rotational loans and mutual support (Yami, 2013). Voluntary community gatherings are therefore common and people meet collectively for religious celebrations, burials, weddings, and to support families in distress or to solve conflicts. In addition, local government frequently calls all adult neighbours for political matters or to request labour contribution, for example, for the maintenance of watersheds in the highlands, as was observed during fieldwork.

The Northern Mendoza Basin occupies about 25% of the total provincial area (almost 40,000 km^2) and contains almost 80% of the Province's population[194]. The prevalent arid climate determines that agricultural production is only possible under irrigation. In the perennial crop areas, most surveyed farmers grew wine grapes (76%) and stone fruits; in the annual crop areas, surveyed farmers cultivated vegetables in several rotations per year. Water resources from the Mendoza River and the Lower Tunuyán River are the backbone of the socio-economic development of this basin in terms of household use, agriculture, agro-

[193] A recent governmental proclamation details the requisites to establish and participate in irrigation WUAs; this policy seeks to solve problematic water governance resulting from co-existing diverse types of irrigation organisations (MWIE, 2014; Imburgia, 2019).

[194] Total population of the Mendoza Province (2010): 1,738,929 (INDEC, 2010).

industries, a growing tourism sector related to rural and natural environments, and hydro-electric power production. Water resources in this region are also affected by rapid urban growth over rural and natural areas, plus contamination of irrigation canals by solid waste and groundwater overdraft (DGI, 2015; 2016).

The hydraulic infrastructure of the Mendoza Province follows a layout of main (primary canal), branch (secondary canals), and distributary canals (tertiary canals) up to field channels. About 85% of the conveyance and distribution systems consist of irrigation canals constructed in natural or compacted earth. This entails significant challenges for management such as infiltration and loss of irrigation water, and growth of vegetation in banks obstructing water flow. Most SSIS use furrow and basin surface irrigation. All landowners with a registered irrigation water right are compulsory members of the WUA of their land's jurisdiction. Those WUAs are non-governmental, decentralised self-governed organisations responsible for the administration and maintenance of secondary and tertiary canals (Imburgia et al., unpublished manuscript-b).

The agricultural production sector of Mendoza has been severely affected by fluctuating political and economic conditions, unfavourable exchange rates and very high levels of inflation for decades. In the last decade, input costs grew exponentially while market prices have been very low for farmers. This complex context, exacerbated by a prolonged drought since 2005, has created a severe sector profitability crisis that has particularly affected the small and medium scale farming sectors (Saieg, 2017; Montes de Oca, 2018). As a result, a large proportion of agricultural water users (who form the backbone of the provincial water management system) are now operating under precarious conditions, and the entire provincial water management sector faces serious threats to sustainability (Imburgia, 2017; Imburgia et al., unpublished manuscript-b). A growing process of land abandonment and/or a shift to non-farming uses of rural land is affecting a significant amount of productive areas of the Province (DGI, 2015; 2016). In the survey, the majority of smallholders interviewed in Mendoza were managing their farms with a minimum of inputs, old or already obsolete farming tools and equipment, and increasingly, minimum maintenance work. As a result, an increasing number of farmers must rely on non-agricultural incomes to make ends meet.

Rural areas in Mendoza are experiencing a rapid change, both in demography and in socio-economic composition. There is an aging rural population, with most farmers having prioritised education for their sons and daughters who then rarely return to live in rural areas.

However, over the last three decades, the farming sector of Mendoza has attracted large numbers of seasonal and permanent migrants from Bolivia and northern Argentina. These migrants usually bring strong farming traditions. In addition, many rural areas located near to the large urban areas of Mendoza, have attracted real estate businesses. This has resulted in a rapid change of soil and water use into recreational and peri-urban uses.

Framed by these complex contexts of environmental, socio-economic and technological change, the remainder of this paper explores the mechanisms of gendered participation in the management and leadership of self-governed irrigation schemes of Tigray and Mendoza.

8.4. Participation in self-governance of small-scale irrigation systems (SSIS)

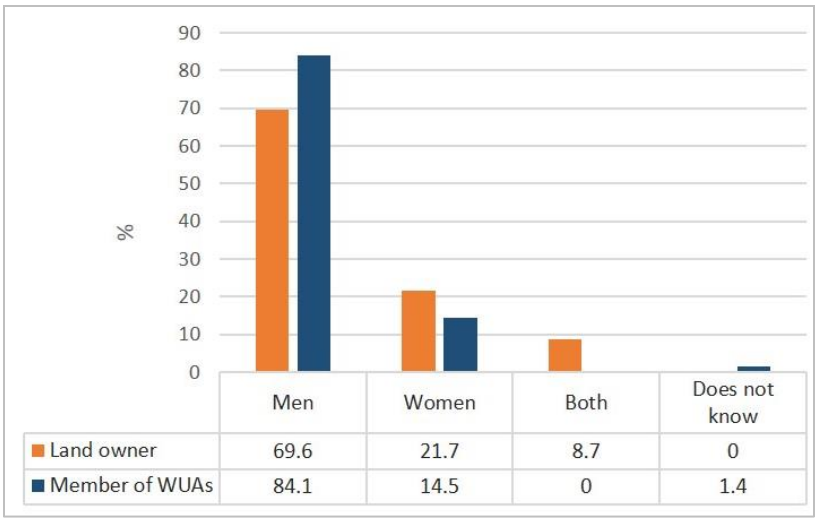
8.4.1. Gendered mechanisms of participation in WUAs of Tigray and Mendoza

Participation of water users in the self-governance of collective irrigation schemes, i.e., in WUAs, is determined by a combination of legal, organisational, financial, socio-cultural and environmental factors (Muchara et al., 2014). In both Tigray and Mendoza, land tenure rights and associated water rights are the most important determinants of inclusion and exclusion in WUAs (Imburgia et al., unpublished manuscript-b). In both research locations, fieldwork findings revealed a number of additional interrelated factors defining the who, why and how of participation in SSIS governance. The motivations and level of involvement in WUAs' activities are useful proxies to characterise effectiveness of the participatory process to enforce fulfilment of users' obligations and responsibilities, and to exercise decision-making power in collective governance. This section will characterise participation by presenting results and findings according to: (1) rules of entry to the collective management of water, (2) the level of involvement, and (3) the reasons and motivations for participation.

(1) Who participates in WUAs? – Inclusion and exclusion factors

In both countries, by law, farmers with land in the command area of an irrigation scheme are entitled to use irrigation water in proportion to the size of their land holding through their WUA membership (Pinto et al., 2006; MWIE, 2014). The formal WUA membership is thus based on land tenure rights. Although Argentina and Ethiopia have land policies that allow men and women equal access to land rights ownership, in both study locations, women were found to have less independent land rights than men (Imburgia et al., unpublished manuscript-c), and therefore, less independent membership in WUAs. In Mendoza, the private property inheritance regime has been egalitarian for both men and women for a long time; however, during the fieldwork, it was less common to find women, whose husbands (or another male relative) were identified as the WUA member, owning land rights (Figure 8.2).

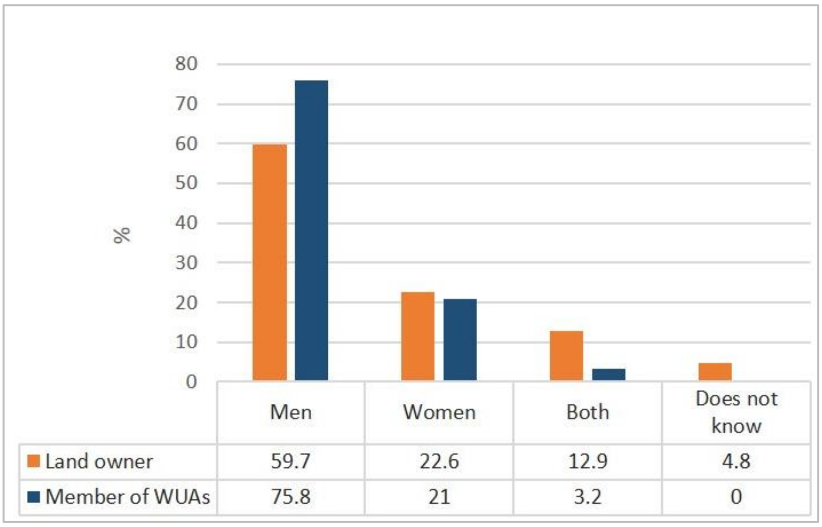
Figure 8.2 Nominal and operational membership in WUAs by gender in Mendoza



Source: Survey of farmers. July-December, 2016; May-June, 2017. N=69.

In Ethiopia, a recent policy change in 2014 allows the registering of land in the joint names of husband and wife, modifying the previous rule of registering land in the household head's name only, usually the husband (Bezabih et al., 2016). Although now women have independent access to land, in the study locations of Tigray, fieldwork revealed that WUAs continued to register membership according to the household head. As a result, in households that indicated owning a joint land certificate, the husband tended to identify himself as the WUA member (Figure 8.3). Most women heads of households were found to be exercising their WUAs' membership rights (except two women whose older sons were the indicated members).

Figure 8.3 Nominal and operational membership in WUAs by gender in Tigray



Source: Survey of farmers. January-February, 2016; March 2018. N=62.

In addition, women who were registered members of WUAs did not always assert their membership rights. For example, in Mendoza, even in households with the husband and wife present, the man would act as the household representative in the WUA. This was evident even though the land was registered in either the women's name or jointly. A similar situation was reported from Nepal (van Koppen et al., 2001). Likewise, a parallel study found that decisions regarding irrigation and crops were mostly made by husbands or male relatives (Imburgia et al., unpublished manuscript-c). Moreover, informants of Tigray and Mendoza indicated that many female landowners rent out their irrigated land and leave farming. This was explained by Imburgia et al. (unpublished manuscript-c), who found that in both research locations, many women farming on their own face more technical, managerial and financial constraints than men because the specific needs and abilities of women in irrigation are frequently poorly considered by irrigation projects.

In both countries, only registered members of the WUAs exercise their formal participation rights. However, authorised (non-right holders) water users -usually family members of the right holder, tenants[195] or sharecroppers- are allowed to attend meetings, claim their water share or inform of problems or conflicts with other water users. In Mendoza, 53% of the survey respondents were registered members of WUAs, and 47% were authorised water

[195] According to the WUAs' policy of Ethiopia, irrigated land tenants must adhere to all rights and obligations related to the water rights during the tenancy (MWIE, 2014).

users. Of those non-member farmers, the majority were relatives of the landowner (75%), and the rest were tenants (8%) and sharecroppers (17%). In Tigray, the situation differed with 92% of survey respondents being water right holders, while the remainder (8%) were family members authorised to use the irrigation water. This information is important to define the type of participation those respondents are allowed to have in the WUA. It also may indicate a relatively lower direct involvement in farming of the actual water right holders in Mendoza, contrasting with the higher direct involvement of water right holders in irrigation and farming in Tigray.

By not exercising their rights to independent membership in WUAs, many women do not exercise autonomy to participate and decide. They also miss opportunities for attending training, acquiring skills and abilities in the irrigation management sector, and socialising with peers. As a result, those women do not enjoy the 'empowering effect' that an active participation has the potential to provide (White, 1996; Cornwall, 2003). These issues reinforce the (misleading) concept that irrigation management is *not* a matter for women. In addition, it adds layers of difference and inequality to the structural socio-economic and gendered-based constraints of rural women.

(2) How do small-scale water users participate?

In both Tigray and Mendoza, the formal mechanisms of participation of farmers in registered WUAs were attendance to users' meetings; labour and financial contribution; electing WUAs' authorities; and holding office positions, which included leadership of associations. Among the most preponderant factors shaping how people participate, the analysis found the following: organisational or system rules; role of farming in the livelihood strategy of the household; personal characteristics, and motivations to participate. These factors will be discussed in the rest of this section.

The most basic form of participation in WUAs is attendance at users' meetings. These meetings are important because they are venues for accessing information, exercising one's voice and making formal decisions regarding water management, including approving budgets, and evaluating the water committee's (WCs) performance.

In Mendoza, the central water agency establishes that WUAs must conduct two official water users' assemblies per year, one for agreeing on the WUA's budget and the other to assess the cash flow. Key informants indicated that participation was usually very low with no sanctions for non-attendance. Results from the survey showed that 41% of farmers never attended meetings. Of the 59% who attended, there was a clear difference between men and women, with 84% men; 15% women, and the remainder 1% couples indicating they both attended. These results were corroborated by observations in a sample of 15 WUA's assemblies in the entire Province. They showed that only 13% of attendants were women. Most of the women present were wives accompanying their husbands, or women farming on their own.

In registered WUAs in Tigray, rules prescribe weekly planning and monthly monitoring meetings. Farmers requiring water were allowed to participate in the weekly meetings and make their water requests. Key informants interviewed indicated that women farming on their own were allowed to be absent from these meetings because of their heavy workloads with domestic and farming tasks. In addition, WCs conduct monthly or bimonthly monitoring meetings, where broader issues related to irrigation performance, production, marketing of products or irrigation related conflicts are discussed. Agricultural experts may participate in these meetings and provide technical advice or communicate governmental agricultural news[196]. In addition, these meetings include an annual evaluation of the WC's performance and cash flow; also, water leaders are confirmed in or removed from their position by election of all members. Those farmers who do not attend these meetings are sanctioned with a fine that may cost the equivalent of up to one daily labour payment. Most male and female heads of households indicated that they attended these meetings. Married women only attended if their husbands were unavailable or if they held their own land certificates.[197]

Likewise, farmers usually must comply with labour and financial contributions to the collective management and infrastructure maintenance. In Mendoza, farmers must contribute labour to clean a portion of tertiary canals (Imburgia et al., unpublished manuscript-b). Women farming on their own have to pay labour to perform this task. The problematic fulfilment of this responsibility and the poor capacity of WUAs' leaders to enforce rules are usually the most contentious issues discussed in WUAs (Imburgia et al., unpublished manuscript-b). All farmers must pay water service fees proportionally to their land size. Failing to pay for more than two monthly periods gives WUAs' leaders the

[196] Agricultural officer, lowlands (male) [E_Wa-ID-02] 27/01/2016.

[197] Due to the recent implementation of land policy changes in Tigray, only young married women were found holding their own land certificates. Source: Fieldwork observations and interviews, March 2018.

authority to suspend water delivery. In Tigray, farmers must contribute labour to canal cleaning and infrastructure maintenance where surface water and furrow systems are used. Farmers pay a monetary sanction for not cleaning their portion of the canals. WUAs usually charge a membership fee and a monthly fee contribution. Delays in payments also cause monetary sanctions. There are also sanctions for allowing livestock to enter into crop fields. Similarly as is the case of Mendoza, women in Tigray farming on their own must have the financial capacity to pay for labour to clean and repair field channels (Imburgia et al., unpublished manuscript-c).

Registered members of the WUAs are allowed to hold managerial positions in the WCs, including being elected as WUA leader (called *inspector* in Mendoza, and *abomay* in Tigray). WCs were usually composed of the WUA leader with assistance of a directory of three to 12 members. The positions of WUA leader and the proposed water committee members are democratically elected by all WUA members.[198] Each WC hires one or more water guard in charge of controlling water distribution and some maintenance work.

In both countries, WUA rules determine that only registered members can be elected as WUA leaders. Additionally, candidates in Mendoza must have the financial capacity to pay the water fees on time. Most of the people who nominated themselves to be inspectors, had the available time to dedicate to the activity and had a strong interest in the sector. Education level or technical training were not required to occupy this position. Successful candidates usually had influence and social connections in their community and were skilful at lobbying. Anecdotal evidence indicated that in a few cases, power groups within the water management system promoted the election of instrumental candidates for particular interests of those groups. In Tigray, in addition to being registered members of WUAs, respondents indicated that selected *abomays* should be respected, influential and trusted persons in their communities. In addition, they should have some level of education (usually primary school completed).

By applying the adapted typology of participation (as described in Table 8.1), it was possible to characterise qualitatively and quantitatively the participation of the survey respondents according to their type and level of involvement in WUA activities. While participation of

[198] In Mendoza, elections of inspectors are conducted every four years. In Tigray, the performance of the *abomay* is evaluated annually by all members. Members are then confirmed or removed from the position.

registered members may be any of the six types included in the typology, participation of the authorised water users (non-right holders) can only be minimum, passive or activity-specific participation because they cannot participate at the same level as right holders. Quantifications of participation were calculated by assigning 0 (nominal participation) to 5 (leadership), based on the roles water users play in the WUAs, the activities they undertake, and the level of reported involvement in the WUAs.[199] These values were estimated by assessing responses of each interviewee to the following survey questions: attendance to users' meetings, labour contribution, and holding office positions in the WC including leadership. In the case of Mendoza, having voted for the last election of the WUA leader was also considered. The criteria were crosschecked against multiple types of responses in the questionnaire to ensure consistency and to obtain valid responses.

By applying this quantitative characterisation, it was evidenced that the type of participation of the entire household may not coincide with the type of participation of the individual member. Gender differences were identified. These results confirm the critical importance of disaggregating water related data by gender (Miletto et al., 2019). When considering the household participation in WUAs, the low participation of some family members is masked by the participation of those more involved. This characterisation revealed that in Tigray, for the majority of farmers (women and men), their participation is passive, thus, they comply with all compulsory requirements of the WUAs, but have a limited share of decision-making power (see Table 8.3). This may be explained by the hierarchical, top-down managerial approaches of Tigray as also observed by Yami (2013).

[199] The person, who is leader of the WUA, receives a score of 5; those who are not leaders but are members of the WC, receive a score of 4; those who fulfil all or most of duties and responsibilities including attending meetings and may fulfil additional (voluntary) WUA' activities, receive a score of 3; those who fulfil WUA's compulsory duties and responsibilities to avoid sanctions, receive a score of 2; those who mentioned fulfilling a minimum amount of WUAs' activities, receive a score of 1; and those who are only registered members but do not fulfil members' responsibilities receive a score of 0.

Table 8.3 Type of participation of surveyed water users in WUAs of Tigray according to their level of involvement

Type of participation	Characteristic of the farmer participants within the sample	Proportion in sample at household level % (n)	Proportion in sample at the respondent level % (n)	Proportion within women at respondent level % (n)	Proportion within men at respondent level % (n)
Nominal	Member owns the land and has a water right, but does not exercise collective rights and obligations.	3 (2)	3 (2)	10 (2)	0
Minimum	Farmer is an authorised water user but does not hold a water right; usually is a wife who sporadically replaces her husband in meetings when he is not available.	4 (3)	6 (4)	19 (4)	0
Passive	Fulfils compulsory obligations to avoid sanctions; does not perform other WUA activities and does not hold office positions.	63 (45)	63 (45)	52 (11)	67 (34)
Activity-specific	Fulfils all duties and responsibilities, attends meetings, performs additional (voluntary) activities in the WUAs (e.g., as guard; cluster leader), but does not hold office positions.	14 (10)	13 (9)	10 (2) [a]	14 (7)
Interactive	The member fulfils all duties and responsibilities and holds a position in the WC (e.g., vice, accountant, secretary, financial management).	8 (6)	8 (6)	5 (1)	10 (5)
Leading /transformative	In addition to exercising all rights and duties, the member is the leader of the WUA.	8 (6)	8 (6)	5 (1)	10 (5)
	Total sample % (n)	*100 (72)*	*72 (100)*	*(100) 21*	*(100) 51*

Source: Survey of farmers in Tigray, January-February 2016; March 2018. Notes: ([a]) All belong to an irrigation cooperative.

In Mendoza, according to the level of involvement of water users - either members or authorised water users -, participation of male respondents was mostly distributed between those farmers with minimum, passive, activity-specific or interactive involvement, with more frequent occurrence of passive participation (see Table 8.4). Instead, most women were found having a minimum participation followed by a passive participation. The role that farming plays in the livelihood structure of the households appears to be having an impact in the level of participation of farmers in Mendoza. Farmers display low participation within WUAs when incomes from farming are marginal. In other cases, landowners hire a permanent employee or a sharecropper to manage all issues related to irrigation, including communicating with the water guard and inspector. Those employees or sharecroppers rarely attend meetings, and if they do, they are not entitled to vote.

Table 8.4 Type of participation of water users in WUAs of Mendoza according to their level of involvement

Type of participation	Characteristic of the farmer participants within the sample	**Proportion in sample at household level** % (n)	**Proportion in sample at the respondent level** % (n)	**Proportion within women at respondent level** % (n)	**Proportion within men at respondent level** % (n)
Nominal	Member owns the land and has a water right, but does not exercise collective rights and obligations.	0	0	0	0
Minimum	Minimum exercise of collective rights and obligations to avoid losing the water right, e.g., payment of water fees. May clean canals.	28 (21)	39 (29)	57 (20)	23 (9)
Passive	Fulfils compulsory obligations to avoid sanctions, may vote for authorities (registered members) but infrequently participates in communal activities, such as WUA meetings.	32 (24)	36 (27)	34 (12)	38 (15)
Activity-specific	Fulfils all duties and responsibilities, attends meetings but does not hold office positions. May be involved in voluntary support activities.	24 (18)	13 (10)	6 (2)	20 (8)
Interactive	The member fulfils all duties and responsibilities, participates in the WC and in other community activities, such as social WUA events or communal infrastructure maintenance activities.	15 (11)	11 (8)	3 (1)	18 (7)
Leading /transformative	In addition to exercising all rights and duties, the member is the leader of the WUA.	1 (1)	1 (1)	0	3 (1)
	Total sample % (n)	*100 (75)*	*100 (75)*	*100 (35)*	*100 (40)*

Source: Survey of farmers in Mendoza, July-December 2016; May-June 2017.

(3) Why do water users participate?

Despite the obvious environmental, socio-cultural and economic differences between Tigray and Mendoza, the foremost reasons for participating in WUA activities in both locations were to ensure timely and reliable access to water, and to solve any household or farm-specific water-related problems (e.g., to request repairing a broken bridge or water gate). As one WUA leader from Mendoza explained: ‘When an irrigation scheme works well, people don’t come to the assemblies. When there are problems, people come ‘*en masse*’.’[200] This corroborates previous findings elsewhere (Muchara et al., 2014).

[200] WUA leader Mendoza River (male) [A_3aM-ID-09] 18/08/2016.

However, a key difference in the reasons why farmers participate in Tigray as compared to Mendoza, is the mechanism of participation enforcement. Fieldwork results show that in Tigray, participation is by coercion, thus, farmers participate to avoid sanctions. In contrast in Mendoza, monetary sanctions are less significant (and the society is less hierarchically organised than in Ethiopia); thus, participation appears to be linked to the type of leadership of the inspector, whether he or she was effective at maintaining the good condition of the hydraulic infrastructure and at enforcing rules. It is also linked to the type of social relationships between users and the inspector, and personal characteristics of users (e.g., age, gender, cultural background). For example, according to key informants, farmers increase their (usually low) participation if they have a good relationship with the inspector (they attend meetings to support the WUA's work). Comparatively, those with fewer social ties to the WUA, such as Bolivians farming in Mendoza or water users not living on the farm, participated in meetings less frequently.

In both study regions, interviews with women and men revealed different motivations for men and women's participation. In Mendoza, although all farmers (regardless of their gender) attend meetings to record problems, some male members indicated attending meetings to socialise and to maintain contact with neighbours. This was particularly observed among older male farmers. 'When you work in the field all day, you don't do much. That's why I like to go to the meetings, you share with other people; you meet with your neighbours and you get the news'.[201] Instead, women expressed interest in participating mainly to voice practical problems, which were most frequently related to uncleaned canals and water being wasted.

In Tigray, men and women did not always understand women's participation in the same way. For instance, FGDs with women heads of household revealed the willingness of many women to participate in WUA meetings, despite male leaders indicating that women 'don't want [to attend meetings] because they are too busy.'[202] There were also variations among different groups of women. For example, when women household heads were asked about the usefulness of meetings, they replied that attending was important for them: 'If we

---

201 FGD with male farmers Mendoza River [A_3am-G-01] 30/08/2016.

202 FGD WUA male leaders, highlands [E_Tb-G-01] 03/02/2016; interview with WUA leader, lowlands (male) [E_Wa-ID-03] 06/02/2016.

participate, we can decide.'[203] However, a group of married women said they did not need to attend as they can get the information from their husbands. A divorced woman farmer in the lowlands explained: 'If the women have husbands, they don't participate. If they are divorced or with no husband, they do, they use their right.'[204]

Interestingly, women in FGDs in Kara Adishebo *kebele*, a Muslim-dominated lowland community, explained that women household heads usually attended WUA meetings and were as vocal as the men in speaking up and complaining. This contrasts with their more muted behaviour when they attended other compulsory community meetings. One lady clarified the reasons:

> Women [married and household heads] don't talk in public because they don't want to be seen as 'non-traditional' women. Actually, they are not shy. They just don't want to raise issues in front of men. However, in the WUAs, the women who are heads of household, they are alone, they must feed children, so they speak. They have to.[205]

Similarly, fieldwork results show how policy and institutions influence gender participation in diverse forms. Female irrigation experts in the highlands explained why more women are interested in participating in irrigation management:

> Nowadays, all women are participating in meetings; women have been receiving many trainings [in gender awareness]. Women speak up freely. Sometimes, they talk more than men in meetings, they are not shy.[206]

These findings corroborate previous research indicating that the severity of resource constraints is one of the most influential factors for women to participate and voice their claims regardless of personal conditions or cultural constraints (Agarwal, 2010). It implies that the level of pressure to find solutions, conditions the way women respond to traditional barriers to participation.

---

[203]FGD with female heads of household [E_Ka-G-03] 14/03/2018; open conversation with divorced female farmer [E_Wa-Op-04] 06/02/2016.

[204] Open conversation with divorced female farmer, lowlands [E_Wa-Op-05] 26/01/2016.

[205][E_ Ka-G-03]

[206] Irrigation experts, highlands (female) [E_Em-Op-01] 02/02/2016; [E_Tb-Op-04] 04/02/2016.

If women are not equally or appropriately represented, they cannot address their water needs; they are unable to sustain water management costs and as a result, are forced to leave the sector. This shows a failure in the WUAs' performance and participatory objectives. In both countries, findings show that women as users of irrigation water are not equally represented in WUAs. Moreover, they are extremely underrepresented in the leadership of WUAs; reasons for this gap in leadership will be discussed in the remainder of this section.

8.4.2. Women in leadership of WUAs

At the time of conducting research in both countries, the participation of women in leadership of WUAs was extremely low. Out of the 23 registered associations in the two *kebeles* in the highlands of Tigray, there were only two female-led WUAs (8.7%) (Embahaste and Tsibet). In the lowlands, none of the 15 registered WUAs (by 2016) had a female *abomay*. Of the 142 WUAs in the Mendoza Province, only two women were *inspectoras* (1.4%); and only one of them was validated in her position and re-elected (in 2018).

Four illustrative cases of women in leadership in Tigray and Mendoza offer insights to women's motivations and constraints to holding leadership positions in WUAs (see Box 1). The most frequently-mentioned reasons from women to explain why they did not occupy leadership positions included: membership requirements (inclusion/exclusion factors); women's workload and time availability; women's education and technical training levels to perform water management work; the self and others' perceptions of women's capacity to lead WUAs; the (perceived and actual) physical and technical difficulties to do the work; and the social and power relations of gender persistent in the irrigation sector. These factors will be discussed next.

Box 1 – Four illustrative narratives of women in leadership positions in Tigray and Mendoza

Embahaste kebele, Tigray, Ausehue WUA. Mrs. F. [E_Em-ID-02] was elected as the first female *abomay* of the sub-district by mid-2016. She is a widow with five children. She reached grade fifth of primary education. She manages a group of 24 farmers, of which 16 are women. They are allowed to irrigate during the day.

> Men were doing a good job leading the WUA here. The work is not difficult, we have our rules. If we respect them, there is no problem. But the women farming in the community started to ask 'why women cannot be abomay?' From the Agricultural Office they supported that women were selected. […] Men complain that I am too strict with respecting rules. This is the only problem I have now (15/03/2018).

Tsibet kebele, Tigray, Chanti May WUA. Mrs. C. [E_Tb-ID-01] was elected as the first female *abomay* of the sub-district by the end of 2017. She is a widow and lives with three grown-up children. Her management area is owned by 17 members, of which about half were women heads of household. All of the men and three women voted for her to be *abomay.* The rest of the women members have their land rented out and therefore they did not vote. The local Agricultural Office also supported her nomination. By the time of the interview, the lady was having conflicts with farmers because they were unwilling to raise the salary of the water guard, who for this reason left his job. She was therefore having problems managing the irrigation scheme.

> I want to leave the position. But the other women push me to stay. This is difficult. Men don't accept what I tell them. They don't respect the rules (16/03/2018).

Canal Matriz Lunlunta, Mendoza River Basin, Mendoza. In 2018, Mrs. E. [A_3aM-ID-39] was re-elected for her third consecutive four-year mandate as *inspectora de cauce* (WUA leader). She is married with two small children. In 2016, the WUA had 649 water users in an irrigation scheme of 1,640 ha.

> I was born here, all my family has farmed [here]. It is what I love to do. But it hasn't been easy. All my colleagues are men, some support my work but I have to fight. Sometimes, they don't invite me to meetings or to technical trips because they want to speak freely among men. Last year, the water office did a financial audit because of rumours of mismanagement. I had to resist and to show that all was being managed appropriately. Some people wanted me to leave. I stayed because farmers came to my house and told me to resist. Last year, I was re-elected with more than 70% of votes (20/04/2016; 04/04/2019).

Hijuela Pampa, Tupungato, Upper Tunuyán River Basin, Mendoza. Mrs. S. [A_Ts-ID-36] was elected WUA leader in 2006 and was in the position for eight consecutive years. She is a divorced, mother of two grown-up men. She has a university degree. In 2016, the WUA had 31 members and 525 ha.

> I started farming alone in the 1990s when I got divorced. I had to survive with my children. At 23 years old, I was accepted as the only female member of a technical association of powerful large landholders that were producing for the export market. We wanted to install a modernised irrigation scheme in this area, a large water reservoir that could supply naturally pressurised water to the farmers. That's why I nominated myself as *inspectora*. I wanted to improve the association. But after the two periods, I had enough. You cannot change the system (17/10/2016).

As explained in the beginning of this section, women in Tigray and Mendoza have markedly less independent membership in WUAs than men. This is a structural barrier for women to become WUA leaders. The next most typical reason mentioned by men for low female presence as leaders is a lack of time, due to women having heavy domestic and production workloads. For example, in Tigray, male members of the WCs of the highlands said: 'Women do not want to participate. They have a lot of work burden at home. It is difficult for them [E_Tb-G-01][207]. Another *abomay* of the lowlands also explained: 'For women, being in the WC and coming to meetings is a burden. They work in the field and at home. They don't need to participate' [E_Wa-ID-03][208]. Although in these two locations women are clearly involved in most of the farming work and in charge of most of the domestic responsibilities (Imburgia et al., unpublished manuscript-c), some women indicated willingness to participate. Furthermore, illustrative cases demonstrate that women have the ability to organise their time and workload to fulfil all those tasks (see Box 1). Nevertheless, those women face multiple challenges, as explained by the only woman inspector in the Mendoza River Basin:

> You may be needed at the middle of the night if there is a problem or a water robbery. You have to be prepared and have a supportive management structure and trustworthy water guards. Most women do not want to do this job, or they just cannot.[209]

Another common explanation given by respondents for the underrepresentation of women as WUA leaders was that the operation of the irrigation schemes is physically difficult for women. However, the women leaders interviewed said that a well-organised irrigation scheme, the modernisation of irrigation systems, and the implementation of effective enforcement mechanisms allowed them to perform the work equally as men.[210] This study found that the installation of pressurised irrigation systems in the lowlands reduced the irrigation workload and management difficulties for all, and, according to informants, it had helped women farming on their own, in particular.[211] It is worth noting that in Tigray, the 'heavy physical effort' identified as an obstacle to women taking up leadership roles is at odds with a government practice observed during the fieldwork. Frequently, rural women and men were called to fulfil watershed management work, which included both genders lifting heavy rocks and moving soil manually.

[207] FGD with male *abomay* and members of WC, highlands [E_Tb-G-01] 03/02/2016.

[208] WUA leader, lowlands (male) [E_Wa-ID-03] 06/02/2016.

[209] WUA leader, Mendoza River (female) [A_3aM-ID-39] 04/04/2019.

[210] WUA leader, Mendoza River (female) [A_3aM-ID-39] 04/04/2019; FGD with female, household heads, lowlands [E_Ka-G-02]05/02/2016.

[211] Agricultural expert, lowlands (female) [E _Ka-ID-02] 05/02/2016; FGD with female farmers in the lowlands, heads of household [E_Ka-G-03] 14/03/2018 and non-head of households [E_Ka-G-04] 16/03/2018.

When the irrigation water has to be distributed at night, the work becomes particularly challenging for women due to security and cultural norms. Nevertheless, in the cases where the community of users were willing to have women lead, the WUA was found to accommodate women's needs. For instance, in a WUA of Embahaste *kebele*, in the highlands of Tigray, the community accepted that the woman *abomay* distributed water during the day to other women (see Box 1). In other cases, having a strong family support system is vital to allowing women's continued participation:

> My husband helps me a lot. He doesn't complain if I have to be out for long hours, he takes care of the kids. He even convinced me to continue when I wanted to resign. I wouldn't have been able to stay without his support.[212]

Women's low participation in water management community activities is linked to the type of household obligations they have linked to childbearing, for example (Bastidas, 2005), that which usually involves a third layer of work burden for them (Moser, 1992; Raha et al., 2013). Three of the four illustrative cases presented in Box 1 showed widowed or divorced women with grown-up children, and thus with relatively lower domestic responsibilities than women with small children. The case of the married inspector of Lunlunta illustrates how the equal share of the domestic workload in the household is a determinant factor of participation.

A barrier for some women to take part in managerial positions was their lack of knowledge about the irrigation system management, which was linked to their lower education levels, and limited access to extension service and technology (Meinzen-Dick and Zwarteveen, 1998; Ongsakul et al., 2012; Theis et al., 2018). In Tigray, women were on average less well educated than men (see Table 8.1) and this may constrain most women from holding office positions that require basic literacy and numeracy skills. It also hinders their self-confidence to hold leadership roles. Just as important is that only a few women, namely, heads of households, attended irrigation management meetings and were called for training. This gap reinforces women's lack of knowledge and self-confidence. Interestingly, despite men and women in Mendoza having similar educational levels, there is a similar pattern of underrepresentation of women in leadership to that seen in Tigray.

[212] WUA leader, Mendoza River (female) [A_3aM-ID-39] 04/04/2019.

In addition to these factors, fieldwork revealed underlying socio-cultural reasons why it is harder for women to be WUA leaders. These reasons were related to gendered social relations of power, as generally, women in leadership positions disrupt the status quo (Meinzen-Dick and Zwarteveen, 1998). Despite their contrasting cultural backgrounds, women in FGDs in Tigray and in Mendoza perceived that men found it hard to be led by women,[213] or that for many men it was difficult to accept that women may have more knowledge than them.[214] Although in Mendoza, open forms of gender discrimination are no longer accepted and are penalised, subtle forms of exercising power were mentioned. For example, women irrigation and agronomy professionals in FGDs explained that it was sometimes problematic for them to interact with male peers if they knew more than men. This was particularly the case with older generations of male professionals.[215]

In Tigray, traditional norms based on religion influence women's access to leadership positions. For instance, in Kara Adishebo *kebele*, a predominantly Muslim community, when women in FGD were asked if they would like to be part of a water committee, a woman head of the women's affairs *kebele* department explained: 'This is a Muslim community. Men and women cannot sit together in a meeting. Women don't even like to sit in meetings with men.'[216]

Overall, the gender differences and asymmetries identified in Tigray and Mendoza related to who participates, how and why, become extremely acute when WUA leadership is considered. The patterns observed in both contrasting countries suggest the need for explicit support to deliver transformative forms of participation, if the ultimate goal is to adhere to equality and sustainability goals. Towards this end, the next section will discuss conditions and opportunities for more inclusive policy and practice interventions in the irrigation management sector.

---

[213] FGD with female farmers in the lowlands, heads of household [E_Ka-G-03] 14/03/2018; WUA leader, highlands (female) [E_Tb-ID-01]; WUA leader Mendoza River (female) [A_3aM-ID-39] 04/04/2019; female farmer, former WUA leader, Upper Tunuyán River [A_Ts-Id-36] 27/10/2016.

[214] FGD female farmers, Upper Tunuyán River [A_Ts-G-05]; Agricultural expert, lowlands (female) [E _Ka-ID-02] 05/02/2016

[215] FGD with female agronomists [A_M-G-01] 17/05/2017.

[216] FGD with female farmers in the lowlands, heads of household [E_Ka-G-03] 14/03/2018 and non-head of households [E_Ka-G-04] 16/03/2018.

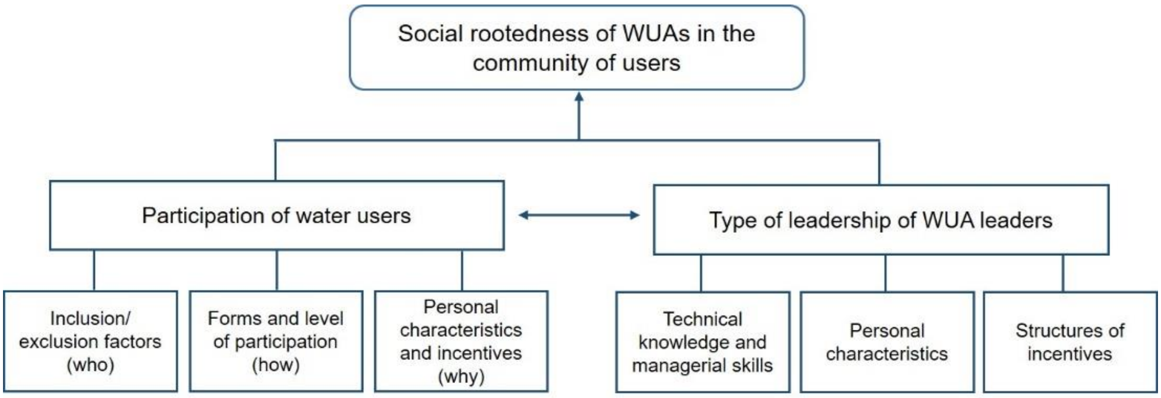
8.5. Discussion and conclusions: Opportunities for more women in leadership

By applying a gender perspective to the analysis of participation and leadership of WUAs, this paper has identified the gender differences and constraints to participation for women, how women are able to access leadership positions, and the challenges to stay in those positions. Findings show how legal factors (rules of entry), personal characteristics, technical dimensions of the irrigation management practice, and social interactions of power all lead to participation mechanisms presenting more challenges to women than to men. Participation of women in irrigation system management is directly linked to their participation in farming, which is constrained by cultural norms and traditions, but also by heavier workloads. This has been described by the scholarship on gender and irrigation (Harris, 2006; Centrone et al., 2017; Lefore et al., 2017) and confirmed by findings of Tigray and Mendoza (Imburgia et al., unpublished manuscript-c).

Similar observations and conclusions on the gendered mechanisms of participation in WUAs have been described in the past (Meinzen-Dick and Zwarteveen, 1998) and continue to be observed, for example, in Ethiopia (Yami, 2013). The present study reveals that current water management systems in both Mendoza and Tigray are reinforcing problems of unequal gender participation, with the direct result of weakened sustainability of WUAs.

The analysis of findings explains that the mechanisms and levels of users' participation in WUAs, and the type of leadership of those associations determine 'social rootedness' of WUAs in the community of users, as conceptualised in Figure 8.4. Participation of water users, as explained by who can participate, how, and why (see section 8.4), is critical to defining the social representation of those users in the self-governance of the water resource. Improved participation is iteratively influenced by effective (good quality) leadership. Findings suggest that the type of leadership of a WUA is due to the technical capacity and managerial abilities of WUA leaders. These aspects become increasingly important when irrigation systems are modernised and become more sophisticated (e.g., pressurised and automatised irrigation systems) (Imburgia et al., unpublished manuscript-b). Leadership is also determined by the personal characteristics of a leader and the type of incentives that the system offers to attract skilful, motivated and accountable leadership.

Figure 8.4 Conceptualisation of participation, leadership and their effect on WUAs' rootedness in the community of users



Source: Developed by the author.

Users' partial participation in WUAs results in organisations being poorly 'rooted' in the community of water users. This affects the effectiveness of the self-governance of the irrigation system. As a result, often fragile WUAs have the responsibility to manage a vital resource in increasingly difficult and complex management contexts (see Imburgia et al., unpublished manuscript-b for an account of the role of WUAs in such complex contexts). Most women experience more constraints for equal access to membership, participation and decision making. These are clear factors highlighting incomplete participation in the self-governance of the irrigation water resource.

It is not straightforward to gauge the effects of increased female participation in irrigation scheme management as in both locations (like in many other countries as well) the participation of women in leading positions is extremely low. However, evidence from this study shows that women have a particularly strong interest in the long-term maintenance of the irrigation infrastructure, cleaning canals and supporting the fair distribution of water. This is noteworthy and deserves further investigation, as it suggests a certain long-term perspective often found in women in developing countries (Bennett et al., 2005; Perkins and Walker, 2015). From the selected illustrative cases of Tigray[217] and Mendoza[218], the very few female-led WUAs were able to greatly improve the transparency of budget allocation, compared to their male predecessors, and they were the most active WUA leaders in fighting

217 Agricultural officer, lowlands (male) [E_Em-ID-02] 27/01/16; FGD female farmers, heads of household, highlands [E_Tb-G-03] 13/03/2018.

218 WUA leader Mendoza River (female) [A_3aM-ID-39] 04/04/2019; female farmer, former WUA leader, Upper Tunuyán River [A_Ts-ID-36] 27/10/2016.

corruption in water distribution related issues.[219] In addition, the idea of fair distribution of water and equitable enforcement of rules were recurrent issues discussed in interviews with women participants. Women in FGD in Tigray spoke of feeling more motivated to attend meetings if a woman was leading them.[220] Similarly, in Mendoza, women indicated being comfortable in the meeting because a woman was the leader.[221] D'Exelle et al. (2012) found water was shared equitably when women were in charge of water management.

These findings reinforce the call for active improvement of opportunities for female participation in the irrigation management sector. Two key aspects that need to be improved to deliver inclusive participation and sustainable resource management: first, it is necessary to quantitatively increase the participation of women. There is evidence that increasing the number of women in a communal group of resource management has a positive effect on the participation of other women who become more confident to take part and voice their needs (van Koppen et al., 2001; Agarwal, 2010; 2015; Mommen et al., 2017). For this to happen, formal access to land tenure of irrigable land for women is vital (Van Koppen, 2017; Imburgia, 2019). It is also essential in order to achieve the human right-based approach to agricultural water for smallholders and vulnerable farmers, including many rural women (Van Koppen et al., 2017; Mehta and Langmeier, 2019). Second, there is need to improve the capacity of women to lead effectively by providing appropriate training and capacity building. Those women who are willing to lead should be able to acquire the necessary skills to effectively exercise those leadership roles. These two aspects can be addressed by imposing rules of entry (quotas) complemented with the provision of technical knowledge, raising the awareness of the importance of more women in leadership, and establishing specific conditions to facilitate the participation of women.

Existing strategies to increase the participation of women provide useful ground for analysis and improvement. Women-only groups are recognised to have successfully improved participation of women in several contexts; for example, in India. This is because those

---

219 FGD female farmers, non-heads of household, highlands [E_Em-G-03] 15/03/2018; FGD female farmers, heads of household, highlands [E_Tb-G-03] 13/03/2018; DGI Mendoza River Delegate (male) [A_M-ID-16] 29/08/2016; manager 2nd grade WUA (male) [A_3aM-ID-05] 28/07/2016.

220 FGD female farmers, heads of household, highlands [E_Em-G-02] 13/03/2018; FGD female farmers, non-heads of household, highlands [E_Em-G-03] 15/03/2018.

221 Short conversations with various female farmers in WUA assembly, led by female WUA leader [A_3aM-O-16] 26/10/2016.

groups allow women to enjoy spaces and activities of their own interest and identity (for water resource management see for example Raha et al., 2013), and probably because stringent customary (patriarchal) social structures and social hierarchies are not challenged. In order to increase women's participation in water governance, Raha et al. (2013) observe that a double-track approach is useful, where integration of both men and women in project activities and women-only activities might enhance women's participation in policy and practice of water governance. In Mendoza, Imburgia et al. (unpublished manuscript-c) comment on a similar approach successfully implemented by the provincial government; it is the implementation of an agricultural programme for the modernisation of farming machinery of smallholder families. In parallel, groups of wives of the male members have established their own agri-businesses. This example outlines the potential to implement similar strategies in the irrigation management sector, for example, through technical capacity development adapted to the needs and interests of women.

In the traditionally male-dominated water institutions of Tigray and Mendoza, there is a clear need to educate water management officials to recognise the capacity of women in technical and management positions in water governance. More women need to be trained and employed in water agencies at higher hierarchical levels. To place more women in these positions will be only possible through a cultural change fostered by explicit and effective policy frameworks. In Tigray, there is clear evidence that effective policy (e.g., land registration policy) and the proactive gender awareness efforts made by the government and international cooperation programmes, has positively influenced the sector and resulted in the inclusion of more women in management and leadership of WUAs. However, this willingness to increase participation of women must be continuously supported, most importantly, at the local administration and irrigation scheme levels. Otherwise, participation of women appears to be hard to consolidate, as shown by the examples from Mendoza. Gender integration and equality policies in the water sector, are therefore imperative.

9. Conclusions

9.1. Introduction

The overall aim of the study was to understand and describe livelihood processes of gender roles and relations in self-governed communal small-scale irrigated systems, in two widely divergent cultural and economic settings. These were the irrigated areas of northern Ethiopia and central Argentina. Drawing on empirical data from these localities, the study examined three core themes of irrigation and gender equality: (1) the patterns and dynamics of gender roles and relations in collective water governance; (2) the changing interactions between actors due to changing patterns of participation and decision making in local water resource management, and (3) the opportunities, conditions and challenges for increased participation and decision making of women in water resource management. This chapter presents a synthesis of the findings from the analysis chapters. It first provides an overview of the research structure and rationale; it also reflects on the development and application of a new integrative conceptual framework for the study of NRM, which was specifically developed for this research as a gender-analytical approach. Second, the findings for each core theme are presented, which are drawn from the individual academic articles prepared for publication, and the significance of these findings is discussed. Finally, this conclusion chapter considers the theoretical, policy and practice implications of the research findings, and opportunities for future research.

9.2. Study rationale

From the perspective of development theories, studies on gender, women and irrigation, framed by the prominent gender and development (GAD) framework[222], have explored the multiple factors that influence the involvement of women and men in irrigated agriculture. Central to the GAD analyses has been the importance of considering social relations in understanding the relationship of women and water (Ray, 2007). In the last few decades, however, theoretical and methodological development to more accurately address issues of women, gender and environment within GAD have moved at a slow pace. While detailed scholarship on gender roles in irrigation agriculture were prolific two decades ago, empirical,

[222] See Chapter 2, Section 2.1.4.

peer reviewed studies with robust theoretical support have been less frequent in the literature recently. This seems to have been translated into poor implementation of potentially effective policies (Ray, 2007), as has been the case in broader aspects of women's rights (Cornwall and Edwards, 2015). Internationally, there was a recognition that the MDGs were far from being delivered upon, and that the implementation of the SDGs also show shortcomings in reaching equality for all in the water sector. This requires renewed attention to the participation of women in irrigation[223].

While a number of conceptual approaches have contributed to broadening our understanding of gendered involvement in irrigation, in practice those conceptualisations are difficult to operationalise.[224] Moreover, evidence suggests that many technical intervention programmes in agriculture and irrigation management have led to significant acceleration of social stratification and gender-differentiated outcomes, undesirable shifts in power structures, and decreased equitability in access to resources and means of production, with evidence of women becoming a marginalised group in irrigation systems (Van Koppen, 1998; Zwarteveen and Meinzen-Dick, 2001; Harris, 2006; 2008; Lefore et al., 2017).

In reviewing the existing literature on women, gender and irrigation, and in revisiting theoretical approaches and operational methodologies used to study issues of irrigation and gender (Chapter 2), it became apparent that there was a need for a comprehensive and theoretically robust framework that allows for the capture of holistic views of the complex interactions inherent to the operation and governance of natural resources, including irrigation systems. This study addressed this analytical need by developing a novel integrative analytical approach to NRM that joins and extends three theoretical concepts (FPE, SES, and social relations framework).[225] The new framework aims to make more visible two important aspects that have received to date partial attention in the literature about women, gender and irrigation: 1) the intersections between 'technical' irrigation practices, and practices derived from social interactions in collective irrigation water governance (gender roles and relations in particular), and 2) the effects of those social

[223] Recent theoretical contributions come from the feminist political ecology, for examples, Harris (2006, 2015); Buechler et al (2015), and Thompson et al. (2016); and from the applied research, policy and practice sectors, for example, IWMI World Water Assessment Programme (UNESCO WWAP); IFPRI-REACH.

[224] See Chapter 5, Section 5.1.

[225] Chapter 5 has described the theoretical needs and motivations to develop the analytical framework.

interactions and irrigation practices on livelihood strategies, within the context of the current leading global water governance policies.

In many agricultural contexts today, common gender roles are changing and, in some places, quickly. The drivers of change are complex and context-specific. Therefore, the development of an integrative gender analysis of NRM requires elements that broaden the understanding of *who* accesses and uses the resources, and *how*. This study therefore examined configurations of social relations of power as a core element within the conceptual framework, filtering and/or catalysing the agro-ecological and environmental processes.

Consequently, this study derived three focused research objectives that framed the development of the research papers[226]. The research objectives were:

- **Research Objective 1:** To explore the patterns and dynamics of gender roles in small-scale irrigation water governance in relation to gender relations across different cultures and socio-economic settings.
- **Research Objective 2:** To examine patterns and dynamics of participation and decision making of different groups of women and men in local water resource management, and effects on inequalities and on livelihood processes.
- **Research Objective 3:** To identify and evaluate the conditions, opportunities, and constraints for increased participation and decision making of women at water resource management sector level.

These research objectives were addressed through more detailed research questions, linked to the development and application of the conceptual framework as introduced in Chapter 2. For clarity, Table 9.1 provides an overview of these research questions and related sections in the thesis where they were discussed. The questions and analysis develop a narrative through the thesis, whereby the outcomes of *Research Objective 1* provides a foundation understanding of the processes which are needed to move onto the next objectives (i.e., the findings from *Research Objective 1* in Table 9.1 feed into Chapters 5, 6 and 7). The integrative approach used in this research was an underpinning concept and used to reveal the intersections between the thematic objectives of the study[227]. Thus, there is overlap as these intersecting themes establish a transition between the chapters (i.e., answers to each

[226] Chapters 5, 6, 7 and 8.
[227] As conceptualised in Chapter 2, Section 2.1 and articulated in the new conceptual framework, Section 2.5.

Chapter provide contextual underpinning to build upon in the next chapter). This approach was considered valuable in revealing the integrative nature of patterns and dynamics across the themes.

Table 9.1 Research questions and location in the thesis where they were discussed

Research questions	Section in the thesis where it is discussed
Research Objective 1	
RQ 1.a. What are the strategies or mechanisms (formal and informal) different groups of women and men develop to gain access to and control of irrigation water?	Chapter 5, Section 5.5. Outcomes of small-scale irrigation systems viewed through an integrative gender perspective Chapter 6, Section 6.4. The gendered outcomes of water governance
RQ 1.b. How are the processes of decision making across different cultures and socio-economic conditions in irrigation practice determined in regards to (a) gender roles, (b) power relations and (c) barriers to gender equality?	Chapter 5, Section 5.5. Outcomes of small-scale irrigation systems viewed through an integrative gender perspective Chapter 6, Section 6.4. The gendered outcomes of water governance; (Security of access to irrigation water) Chapter 7. Section 7.5. Examining outcomes and linkages to equality in irrigation water governance
RQ 1.c. Does an increased share in decision-making power in WUAs lead to secured water access for different groups of women? If so, how? Why?	Chapter 5, Section 5.5. Outcomes of small-scale irrigation systems viewed through an integrative gender perspective Chapter 7. Section 7.5. Examining outcomes and linkages to equality in irrigation water governance
Research Objective 2	
RQ 2.a. How changes in governance (decentralisation) impact on water resource management? If there is benefit, who benefits?	Chapter 7. Section 7.6.1. Irrigation self-governance and equality: Enabling conditions for functional WUAs Chapter 7. Section 7.6.2. Role of WUAs in overcoming barriers to equality and sustaining small-scale irrigation
RQ 2.b. Do changing patterns in decision making in WUAs lead to reallocation of resources in favour of more equitable water resource management? If so, how? Why?	Chapter 7. Section 7.6.1. Irrigation self-governance and equality: Enabling conditions for functional WUAs
RQ 2.c. What are the factors and mechanisms that shape participation of different groups of women and men in water governance organisations?	Chapter 8, Section 8.4.1. Gendered mechanisms of participation in WUAs of Tigray and Mendoza

Research Objective 3	
RQ 3.a. What are the constraints, opportunities and enabling conditions for formal and 'transformative' involvement of women in water governance structures and sector policies?	Chapter 8, Section 8.4.2. Women in leadership of WUAs Chapter 8, Section 8.5. Discussion and conclusions: Opportunities for more women in leadership
RQ 3.b. What are the implications for an increased participation of women in leadership?	Chapter 8, Section 8.4.2. Women in leadership of WUAs Chapter 8, Section 8.5. Discussion and conclusions: Opportunities for more women in leadership

In the next section, the main findings and their significance will be presented, according to the overall themes that emerged from the research objectives.

9.3. Main findings and conceptual significance

9.3.1. Analysing patterns and dynamics of gender roles and relations in small-scale irrigation systems (SSIS)

The first research objective of this study explored the patterns and dynamics of gender roles in small-scale irrigation water governance in relation to gender relations across different cultures and socio-economic settings. The study identified gender asymmetries present in a well-established governance system in Mendoza, and in a less developed governance context in Tigray, due to structural inequalities mostly driven by social relations of power and material inequalities. Despite the obvious cultural and socio-economic differences in both countries, significant similarities in those processes became evident.

The application of the conceptual framework explained (see Chapter 5) how the functioning of governance systems and the interactions between structural elements of the framework (i.e., agro-ecological resource systems; actors; and governance systems)[228] are catalysed by social relations of power including those of gender[229]. Four outcomes synthesise these processes and dynamics: (a) security of access, (b) security of livelihood strategies, (c) autonomy, and (d) adaptive strategies[230]. By focusing the analysis on these four specific outcomes, it was possible to organise and describe the most critical factors and mechanisms

[228] These elements were described in detail in Chapter 4, Context.
[229] See Chapter 2, Section 2.5.2, Figure 2.5.
[230] Chapter 5, Sections 5.2 and 5.5

related to the role of women and men in access to, use of, participation and decision-making in water resource management in an effective and timely manner. The key findings from this analysis are discussed below.

Gender-based constraints in the mechanisms to access and control water continue to challenge women in irrigation agriculture

Irrespective of the cultural settings, gender asymmetries and inequalities in irrigation persist. The findings discussed and analysed in Chapter 6 conclude that many women in irrigation agriculture remain constrained by structural inequalities driven primarily by entrenched power dynamics, social relations and wealth handicaps.[231] Likewise, women farming on their own frequently face greater technical, managerial and financial constraints than men. The reasons for these gender-based constraints are generally associated with poor consideration of the specific needs and abilities of women in irrigation management. These issues compound intrinsic disadvantages traditionally attributed to women, for example, in meeting their physical demands of irrigation agriculture. These findings starkly contrast with decades of donor- and government-driven efforts to devise agricultural development policies aimed at reducing gender asymmetries and strengthening the role of women in agriculture.

The most significant structural source of gender inequality in irrigation agriculture continues to be access to irrigable land. Independent access to land and possession of land titles, and the corresponding access to water rights is still less common for women than for men in the two research locations, confirming observations in many developing countries.[232] Moreover, it was found that women, even those holding independent water rights, do not always realise those rights due to gender-based constraints, which included technical and financial capacity, personal attributes and endowments, and social norms and traditions.

Findings discussed in Chapter 6 further showed that robust and well-established legal frameworks increase security of access to water and to formal WUAs' membership for vulnerable farmers, including many women smallholder farmers. However, by not exercising their right of independent membership in WUAs, women do not exercise autonomy to participate and decide. They also miss opportunities for attending training,

[231] Chapter 6, Section 6.4. The gendered outcomes of water governance and 6.5. Implication for policy and practice.

[232] Chapter 2, Section 2.2. Gendered social relations, power and access to resources; Chapter 6, Sections 6.1. Introduction, 6.2. Conceptualising irrigation and gender.

acquiring skills and abilities in the irrigation management sector, and socialising with peers. This unequal representation and participation prevent women from enjoying the 'empowering effect' that active participation can provide (White, 1996; Cornwall, 2003). These dynamics reinforce the old prejudice that irrigation management is *not* a matter for women.

Interestingly, in those places where gender equality policies are in place, such as in Tigray, and where governmental agricultural offices and international donor projects intensively work on gender equality awareness, a positive policy effect was apparent. This supports the validity of gender awareness and equality policies in the irrigation sector and the potential to foster behaviour change.

Irrigation agriculture is a driver of social differentiation influencing gender asymmetries and social inequalities

The findings of this study contribute to the understanding of how and why irrigation agriculture is a driver of social differentiation and intersects with other contextual (i.e., environmental, socio-cultural, and economic) processes (Harris 2008). Key conclusions are:

- *Traditional gender roles, relations and division of labour in irrigated agriculture shape social differentiation processes and restrict women to be equal irrigator actors.* The technical dimensions of irrigation systems and management, and the social relations dimension of irrigation self-governance, suited to the traditional roles and conditions of men in rural areas, place serious physical, managerial and financial constraints on women.[233] Those gender roles directly relate to the extent of men and women's involvement in irrigation practice and management. In both research locations, participation of women in farming was found to be constrained by cultural norms and traditions, but also by heavier workloads[234]. This has been observed in other rural contexts in developing countries and extensively described in the gender and agriculture literature (for example, Momsen, 2010; Palacios-Lopez et al., 2015).

- *Social differentiation processes iteratively influence peoples' decision making and autonomy in the irrigation practice and management.* Study findings add evidence to explain why some groups of women were more constrained than others. Married women,

233 See Chapter 6, Section 6.4.
234 See Chapter 6, Section 6.4.

in particular those at reproductive age, were more disadvantaged in regards to economic independence and decision making than, for example, female heads of households with access to land and the autonomy to make economic (water) decisions.[235] Married women with small children, and elderly widows were particularly disadvantaged by heavy workloads. In many cases, women farming on their own were found engaging in sharecropping agreements with men or renting out their lands and leaving farming due the persistent difficulties faced. This in part explains why the number of women found in water management activities remains low despite years of international policy support of women in agriculture.

- *Access to irrigation technology that impacts on farmers' workload was found to shape participation of women and men in irrigation practice and management.* Findings from the study show that hydraulic infrastructure improvements can reduce the drudgery of infrastructure maintenance work (e.g., canal cleaning) and were of direct benefit by allowing women farm on their own as discussed in Section 6.4. Modernised irrigation systems (e.g., drip and sprinklers) were found to facilitate the involvement of women in irrigation. However, differential access of women and men to irrigation technology may reinforce gender and other social stratification processes. In cases where the viability of irrigated agriculture depends on modernising the irrigation systems (and more efficient use of water), and farmers must pay for it as in Mendoza, financial capacity of smallholders is a critical limitation. As women farming on their own usually incur higher costs, they cultivate less land and earn lower income from farming, female smallholders usually have lower financial capacity to invest in technological modernisation of the irrigation systems.

  Gender-differentiated access to irrigation technology when it is expensive or involves some sophistication may partly explain why many women use less specialised irrigation systems, such as small-scale irrigation technologies (e.g., small pumps, and bucket or rope irrigation) (Centrone et al., 2017). These small-scale technologies, although still important for large numbers of smallholders (mainly those using their own water source (de Fraiture and Giordano, 2014) and notably in SSA (Woodhouse et al., 2017; Theis et al., 2018)), do not reflect the full spectrum of users in small-scale irrigation agriculture worldwide. These observed gender differences restrict the ability of women to become

[235] See Chapter 6, Section 6.5.

equal users of improved technology. When only small-scale technologies with high demand of physical effort and time are accessible for rural women, they remain restricted to irrigating small plots (usually home gardens), and to growing crops for household consumption and not for income. By contrast, findings from Chapter 6 showed that when women accessed efficient and easy-to-use irrigation systems such as drip or sprinklers in Tigray (where the government subsidised its implementation), irrigation was physically and financially accessible for them at the same scale (and with similar constraints) as men.

- *Recent socio-economic processes in small-scale agriculture exacerbate social disparities and foster processes of socio-economic differentiation.* The increasingly low profitability of small-scale agriculture (typical for the subsistence type of agriculture in Tigray, and a rapidly threatening issue in Mendoza) puts at risk the viability of livelihood strategies of small and increasingly impoverished farmers, notably elderly and female farmers with caring responsibilities. Access to irrigated land appears to be critically important to overcome poverty for small-scale farmers. Data from Tigray illustrate that male and female smallholders cultivating irrigated land were better able to secure subsistence than those having only rainfed land[236], as it has also been observed in northern Tigray (Gebrehiwot et al., 2015). In Mendoza, where all farming is dependent on irrigation, external income seems to be the key factor allowing to stay in the irrigation system. In recent years, only those with capital seem to be able to enter the farming sector, provoking a progressive concentration of land and agricultural businesses in fewer holdings. In addition, many farmers go bankrupt, lose their water rights and are obliged to sell their lands and leave agriculture.

- Likewise, findings revealed the current risks originating in a widening gap between those farmers able to cope with unpredictable and recurrent water shortages and those unable to do so because they cannot secure their own irrigation water source[237]. A novel contribution of the conceptual framework developed in this study is the inclusion of adaptive strategies as one of the core elements in the analysis of gendered outcomes of irrigation governance. As findings from this study demonstrate, those smallholders already with difficulties in securing water, farming livelihoods strategies and autonomy,

[236] See Chapter 6, Section 6.4, (2) Security of livelihood strategies and Table 6.1.
[237] See Chapter 6, Section 6.4, (4) Adaptive strategies.

including many women, are less able to adapt and stay in farming. This will likely continue to widen the gap between rich and poor farmers, define those small-scale farmers able to stay in the sector, and reinforce the need for an explicit equality policy in infrastructure management as well as transparent discourses in water scarcity (Budds, 2008; Mehta et al., 2019).

Provided water access is secure, irrigation agriculture has the potential to be an empowering livelihood option for rural women

The gender asymmetries and constraints notwithstanding, many rural women with primary family responsibilities, relatively less mobility than men, and lacking education and resources for entering other economic sectors, still find in agriculture a main source of employment. Findings demonstrate that small-scale irrigation is a central livelihood strategy for women with limited off-farm options provided irrigation water access is secure, reliable and affordable. Irrigation farming is also a livelihood option for those women owing their own irrigable land and pursuing an independent income source[238]. These findings highlight two key points. On the one hand, it corroborates the continued need for explicit attention to women in policy, practice and agriculture research. On the other hand, it underlines the necessity to align agriculture and water policy, and the need to promote coordination and joint development of practical interventions to support women in irrigation agriculture.

Consequently, it is inferred that water policy seeking to reduce the gender gap in participation in irrigation agriculture must be based on a multi-level approach that addresses at least the following aspects: (a) rules of entry (considering own legal access to water rights and independent access to WUAs' membership for women, in particular for married women); (b) financial capacity; (c) knowledge and technical skills; and (d) advocacy for cultural change. The analysis of WUAs in Tigray shows that recent policy changes towards formalisation of the irrigation management sector has helped to establish better transparency of rules and regulations, which have improved security of access to irrigation water for certain groups of previously disadvantaged female farmers. Those women -who have secure access to their own water- have increased their involvement in WUAs.

Overall, the increased representation and participation of women in agriculture contrasts with low representation of women in irrigation management. This is the result of a mixture

[238] See Chapter 6, Section 6.5.2.

of diverse factors, mostly driven by social, cultural, technological, and financial asymmetries, which persist and are engrained within rural communities. When not purposively and explicitly addressed, those asymmetries are reproduced in community organisations, which hinders the potential benefits from collective action - as this study found when exploring gendered issues in WUAs in Chapter 7 (discussed in section 9.3.2 below).

9.3.2. Analysing the role of WUAs in equality, in livelihood processes, and in the broader rural development context

The second research objective was to examine patterns and dynamics of participation and decision making of different groups of women and men in local water resource management, and effects on inequalities and on livelihood processes. The analysis of outcomes in irrigation governance systems illustrated the extent to which changing patterns of participation and decision making due to, for example, decentralisation and irrigation management transfer, influenced gender equality in water access and management, and gendered impact on livelihood processes.

In Chapter 7, the study examined the influence of WUAs on equality and agricultural livelihood processes under the serious and growing challenges of water scarcity, and market, political, demographic, and environmental changes. While the self-governed irrigation management systems of Tigray and Mendoza differ considerably in terms of the complexity, the level of autonomy from government and the costs of operation and maintenance, their comparison was greatly facilitated by the new analytical framework. The implementation of the analytical framework allowed an exploration and comparison of governance processes and patterns in these two systems. Common patterns in these empirical results across such diverse settings suggest the possibility of extrapolation of conclusions.

Deficient managerial capacity of WUAs and political interference result in inequalities in irrigation self-governance with smallholders being the most affected water users

Despite the obvious contextual differences, the two contrasting research settings showed similar patterns in WUA performance and challenges to equality. WUAs in both locations fulfil their basic mandate of water distribution and hydraulic infrastructure maintenance. However, management practices are deficient and not well adapted to the current water and agricultural sector challenges. In both cases, those management practices were found to be strongly constrained by infrastructure deficiencies derived from a lack of public investment and political interference. In addition, deficient managerial capacity of WUAs (i.e., poor enforcement of rules; poor capacity to collect water fees; WUA leaders unaccountable to farmers) determines conditions of insecure and unequal access to water. As a result, smallholders are the most affected when they cannot secure their vital agricultural livelihood. In turn, WUAs become financially weak to afford managerial costs.

The similarities found can be explained by similarities in decentralisation and irrigation management transfer worldwide (Garces-Restrepo et al., 2007), regardless of the particular local conditions. The analysis of the WUAs provided empirical examples showing that the functioning of the WUA model under processes of decentralisation and devolution implemented during the 1980s and 1990s continue to show mixed results, with some locations being successful and others failing to achieve the expected results, as described, e.g., by Senanayake et al. (2015). Moreover, this finding substantiates the argument that incomplete processes of irrigation management transfer to water users result in WUAs with problematic financial and managerial viability (Garces-Restrepo et al., 2007).

The incomplete decentralisation affects equality and the viability of WUAs. Thus, WUAs become fragile institutions expected to manage an increasingly complex resource. By contrast, when the management transfer included technical support from the central water agency, such as observed in some WUAs of Mendoza, decentralisation showed higher degrees of completeness, and this resulted in better WUA performance.

Importantly, results also revealed that more efficient, ‘well-performing’ WUAs were those that, in addition to organising secure and timely water distribution, emphasised rules and practices focused on equality. This confirms observations in the scholarship of the commons, as higher levels of inequality are directly related to greater inefficiencies in the use of common public resources (Baland and Platteau, 1999). Moreover, fairness in water distribution was highly valued by farmers, even if there were some managerial deficiencies. Interestingly, findings reveal that in both countries, farmers responded in similar ways to increased fairness, transparency, and equality in WUA management[239], and this resonates with observations elsewhere (Tanaka and Sato, 2005).

[239] See Chapter 7, Section 7.6.1. Irrigation self-governance and equality: Enabling conditions for functional WUAs.

However, it was also found that a disconnect between the policy and management goals of water resource management and the irrigation agriculture sector (in addition to the infrastructural, managerial and financial constraints of WUAs discussed above) hinders the effectiveness of WUAs. Incongruent goals of water management agencies and farmers dependent upon irrigation water is indeed problematic due to, at least, the following reasons:

- Water policies do not always match farming needs in terms of delivering timely, reliable, and affordable access to water. This is largely a result of the supply-based water distribution system, in contrast to the necessary demand-based distribution system.
- Water distribution management does not include training farmers on how to use water more efficiently for increasing yields and for conserving soils (i.e., soil fertility, prevention of soil salinization).
- Agricultural practices towards increasing yields (e.g., use of fertilisers; improved crop varieties; row planting) without combining with proper irrigation practices *and* water distribution systems do not reach their full-expected potential. Moreover, the application of those improved farming practices may even compromise sustainability.[240]
- The collective action potential of WUAs (e.g., input purchase collectively, planning type and amount of seasonal crop productions, collective marketing of produce, collective use of transport to market) remains untapped under rigid water policies not facilitating or even allowing WUAs to engage in activities other than water management and distribution. There is a range of WUA activities and services that would not only improve the financial standing of the associations but also improve farming results for members. Examples exist of countries where WUAs engage in such secondary activities with success, for example, in the well-established self-governance system of Philippines (Garces-Restrepo et al., 2007). In the case of Mendoza, the legal framework in place would allow an expansion of the WUAs' activities.[241] However, the central water agency resists diversification because of one

[240] See Chapter 4, Section 4.3.4. *Constraints in small-scale irrigated farming*, for examples from Tigray.

[241] In 2015, the DGI sanctioned a legal rule that allowed WUAs to develop activities other than those related to water management (e.g., production and services); incomes generated from those activities should be used in the functioning and maintenance of the irrigation scheme. Source: Resolución No. 370/2015, DGI (2015).

case of a failure in a second grade WUA, caused by lack of technical knowledge and mismanagement.

Functional WUAs have a fundamental role in livelihood processes, in the potential to increase equality and in sustaining small-scale irrigation agriculture

Despite the incomplete decentralisation process identified by this study, results show WUAs to be institutions with the potential to play a key role in fostering equality and as catalysers of agricultural and rural development[242]. This is likely to be the case in other communal irrigation systems in which smallholders organised through WUAs represent the economic and social capital of the self-governance of water resource systems, as in both research locations of this study.

The study identified four enabling conditions that will strengthen the role of WUAs to increase equality and support livelihood processes. [243] First, WUAs that rely on robust and stable legal frameworks, but have flexibility to accommodate the changing needs of users, are better equipped to secure water for members and reduce participation inequalities. Second, emphasis on the technical aspects of water distribution and regular maintenance and rehabilitation of irrigation systems are critical priorities in order to sustain equitable access to water. Third, transparent, fair and efficient rule enforcement mechanisms contribute to WUA users' willingness to meet their obligations. Fourth, the use of mechanisms that counteract unbalanced social relations of power improve perceptions of equality, increase users' compliance with rules and make WUA leaders more accountable to farmers.

These enabling conditions benefited those more vulnerable in the irrigation governance system: impoverished WUAs and smallholders. Furthermore, the findings show how those enabling conditions provided women with secure and reliable access to water, and were important factors in increasing participation of women in water management (Findings explaining the gendered mechanisms of participation are highlighted below in section 9.3.3).

The results further show that farmers are able to develop strategies, although imperfect, that help solve individual production problems through their collective-action platform, the

[242] See Chapter 7, Section 7.6.2. Role of WUAs in overcoming barriers to equality and sustaining small-scale agriculture.

[243] See Section 7.6.1.Irrigation self-governance and equality: Enabling conditions for functional WUAs.

WUAs[244]. This, in addition to the fundamental role of WUAs in irrigation water access to smallholders, determines that WUAs stand as fundamentally important actors in sustaining livelihood activities and strategies, with a direct effect on the survival of SSIS. These findings confirm policies supporting WUAs as core element of decentralised irrigation management systems, with the potential to improve equitability and sustainability (Garces-Restrepo et al., 2007).

However, the results also reveal that this potential of WUAs is often underutilised. Faced by the serious and complex problems of the 21st century, WUAs are largely dependent on implemented management procedures and local problem solving that are obsolete or not appropriately implemented. Because the public and development sectors impose high expectations from WUA delivery (Aarnoudse et al., 2018), however, the results indicate that the way WUAs are conceived and equipped is not commensurate with the critically important role and responsibilities they are expected to fulfil. WUAs seem to be too often technically and financially weak entities expected to effectively manage an extremely complex resource.

The success of WUAs to perform towards equality and sustainability goals appears to be strongly linked to two additional important aspects: first, to the 'rootedness' of WUAs in the community of users; second, to more inclusive participation of water users in the management and leadership of WUAs, women in particular. These topics were discussed in Chapter 8, and the key findings are revisited in the next section.

9.3.3. Challenges, opportunities and enabling conditions for more inclusive participation in water governance

The third and last research objective of the study was to identify and evaluate the conditions, constraints and opportunities for increased participation and decision making of women at water resource management sector level. In order to address this research objective, it was necessary to first, explore the gendered mechanisms of participation in WUAs as presented in Chapter 8, and second, reflect on the association between an incomplete participation and representation of water users, in particular women, and the performance and sustainability of WUAs. Key findings are discussed below.

---

244 See Chapter 7, Sections 7.6 and 7.7.

Gendered mechanisms of participation in irrigation self-governance are not fully effective to ensure inclusive participation

The explicit mechanisms of participation in WUAs identified by the study were (a) attendance at meetings, (b) financial and labour contribution, (c) deciding on budget allocation and amount of water fees, (c) electing WUAs' authorities, and (d) holding officer positions.[245] By applying an adapted participation typology[246], these mechanisms of participation were characterised according to three main aspects: (1) rules of entry to the collective management of water (who participates), (2) the level of involvement (how people participate) and (3) the reasons and motivations to participate (why people participate). These factors were useful proxies to comprehensively characterise effectiveness of the participatory process (White, 1996; Agarwal, 2001; 2010) to enforce fulfilment of users' tasks and responsibilities, and exercise of decision-making power within collective action.

Findings from the analysis of participation concluded that the participation mechanisms that are used in WUAs result ineffective to achieve inclusiveness and a balanced decision-making power of water users. Findings revealed that although existing rules of entry allow equal participation of women, cultural norms continue to restrict women's involvement in WUAs. Formal membership in WUAs is based on land tenure rights, and as previously discussed, women tend to have less independent land rights than men, and therefore, less independent membership in WUAs. Moreover, the study frequently found women owning land rights whose husbands or another male relative were identified as the member of the WUA. This resonates with the pervasive notion that irrigation management and all related activities concerning WUAs belong to the domain of men.

How and why farmers participate differently was found to be further shaped by personal characteristics of members, the role of farming in the livelihood strategies of members, and the incentives to participate. For the majority of female and male farmers in Tigray participation is passive. These farmers comply with the compulsory requirements of the WUAs but have a limited share of decision-making power. This can be explained by the hierarchical, top-down managerial approaches present in Tigray, which were also observed by Yami (2013). This is likely to be the case in other self-governance systems of Sub-Saharan Africa (Aarnoudse et al., 2018). In Mendoza, where the society is less hierarchically

[245] See Chapter 8, Section 8.4.1. Gendered mechanisms of participation in WUAs of Tigray and Mendoza.
[246] See Chapter 8, Section 8.4.1., (2) How do small-scale farmers participate?

organised than in Ethiopia, the role that farming plays in the livelihood structure of households has an impact on the level of participation by farmers (both men and women). Farmers show low participation within WUAs when incomes from farming are marginal. Interestingly, some farmers also reduce participation if WUA performance is good and satisfy minimum expectations of secured water access. Mechanisms for participation were found to be greatly influenced by the type of leadership of WUA leaders, with accountable leaders having a positive effect on users' participation.

Participation in irrigation management and WUA leadership imposes greater challenges to women than to men

The analysis of the gendered mechanisms of participation reveals that the irrigation management sector continues to be difficult for most women and that women are under-represented in the management and leadership of WUAs.[247] Scholars on irrigation and gender have consistently highlighted this issue (Meinzen-Dick and Zwarteveen, 1998; Resurreccion et al., 2004; Yami, 2013). By applying a gender perspective to the analysis of participation and leadership of WUAs, this study has identified gender differences and constraints to participation for women, how women are able to access leadership positions, and the challenges to stay in those positions[248]. Due to rules of entry, participation of women in irrigation system management is directly linked to their participation in irrigation agriculture, which is constrained by cultural norms and traditions, and also by heavier workloads as discussed in section 9.3.1.[249]

In agricultural water management (as in agricultural development in general), gender advocacy for increased representation of women has spawned corresponding policies. However, women in leadership positions were found facing greater constraints than men. The reasons for this appear associated with water management systems being adapted to the traditional benefits for men in rural areas, i.e., male priority in land use and tenure; the hydraulic infrastructure deficiencies that condition required physical capacity and workload; better opportunities to access education and employment; priority to access technical knowledge, information, and social networks; and more mobility in public. This may partly

[247] See Chapter 8, Sections 8.4.1 and 8.4.2.
[248] See Chapter 8, Sections 8.4.1 and 8.4.2.
[249] This has been detailed in Chapter 6, Section 6.4.

explain why mostly only those women with financial autonomy and a 'strong character'[250] tend to be involved in irrigation management.

How the system is organised, i.e., the inclusion/exclusion factors (rules of entry, i.e., water rights and land ownership); the hydraulic infrastructure deficiencies; and the traditional intra-household and community social relations of power that pre-define gender roles are all contributing factors that keep women in a disadvantaged position for more active involvement in leadership of irrigation management. This calls for a pro-active advocacy for more women to be involved but also for greater commitment of policy makers and the water bureaucracy to adapt the water management systems towards inclusiveness, e.g., in access to technology, water turns, technical training to women, and mechanisms to limit power abuses as discussed in Chapter 7.[251]

Incomplete water users' participation jeopardises sustainability of WUAs; explicit gender transformation efforts offer opportunities for sustainable water governance

Findings discussed in Chapter 8 demonstrate a direct relationship between the level of involvement of users and the decision-making share and how well or poorly 'rooted' WUAs are in their community of users. Incomplete participation of users results in WUAs not being well 'rooted' in the community of water users, which impacts on the effectiveness of self-governance of the irrigation system. Low quality participation, which according to the participation typology used includes nominal, minimum and passive participation[252], results in farmers having low knowledge of the system, a very limited sense of ownership and an overall distant relationship with the WUA manager. By contrast, a 'well-rooted' WUA is characterised by relying on trustworthy leaders; users have a good knowledge of the irrigation management system; farmers get involved in collaborative work with WUA leaders; rules are transparent and fair for all, and those more disadvantaged receive special support to irrigate. In these types of WUA, farmers were found to comply better with rules and duties and they understood when sanctions were imposed. In addition, users showed a higher degree of satisfaction with the work of the WUA leader.[253]

[250] Illustrative cases were analysed in Chapter 8.
[251] See Chapter 7, Section 7.6.1.
[252] See Chapter 8, Section 8.4.1.
[253] For a discussion of the linkages between equitable enforcement of rules, compliance and accountability of WUA leaders, see Chapter 7, Section 7.5.

Consequently, as discussed in Chapter 8[254], WUAs with incomplete participation are fragile communal institutions with the responsibility to manage the vital water resource in increasingly difficult and complex management contexts. A WUA with poor leadership and managerial capabilities has difficulties enforcing rules and collecting fees, and therefore, maintaining the hydraulic infrastructure, which is the key requirement for secure water distribution.

Women having more constraints than men in achieving equal access in membership, participation and decision making (as seen in the irrigation sectors of Tigray and Mendoza)[255] was revealed as a clear indicator of poor 'rootedness' of WUAs in the community of users (i.e., because most women have incomplete participation in the self-governance of the irrigation water resource). As a result, current water management systems continue to reinforce unequal gender participation, which weakens the sustainability of WUAs because of its incomplete participation. This constitutes a strong argument for legal and institutional mechanisms that make explicit the inclusion of women in the irrigation management sectors within these two countries.

To achieve this goal, corresponding policies must explicitly recognise and respond to the complex interactions between the technical and social dimensions of irrigation agriculture, and the resulting processes of social differentiation. Findings from this study clearly suggest the need for results-oriented gender transformation efforts in the water sector that include (1) explicit inclusion of gender equality considerations in water infrastructure investments; (2) making knowledge directly available to rural women, and (3) strengthening small-scale irrigation agriculture as gender equality and economic transformative policy priority.

9.4. Theoretical and methodological implications

Discourses of GAD and gender analytical approaches

The study has contributed a conceptual framework of gender, access to resources, participation and decision-making to the theories within Gender and Development (GAD) where conceptual development appeared stalled recently. Empirical research on these issues is also less common today as it used to be two decades ago. The traditional (and for practice)

[254] See Chapter 8, Section 8.5.
[255] See Chapter 6, Section 6.4.

gender-analytical frameworks (March et al., 1999) are mostly based on binaries and dichotomies: women/men, female/male head of household; perceptions of a ‘predatory’ man and a powerless woman. Differences in class, status, age, and socio-cultural background are less prominent, and thus hierarchies within different groups of women and men remain non-transparent. While feminist political ecology (FPE) has opened relevant perspectives for more complete and realistic analyses of gender and other social differences in NRM, its engagement with the natural sciences has been cursory; likewise, its operational application remains challenging (see Chapter 2). More operational approaches, such as the social relation approach (Kabeer, 1994; Kabeer and Subrahmanian, 1996), are complex and difficult to apply in designing, planning and implementation of development projects because of the short project cycles. The new integrative analytical framework for the study of gender and NRM therefore intends to fill a theoretical and methodological gap by considering updated and integrative perspectives that does not pose high operational challenges.

Power and effects on social relations as central elements of the conceptual framework

The study has assembled diverse theoretical elements for a comprehensive and multidimensional examination of the issues of water governance, gender and livelihood processes. These theoretical foundations were structured around the concept of power and how it affects social relations as core elements catalysing agro-ecological processes and activities, livelihood processes, and social differentiation and equality. In particular, the attention to social relations of gender, relations of class and socio-cultural background has been central in the analysis. The aspects of power associated with the management of natural resources was incorporated through the FPE perspective, which offers a useful framework of analysis regarding how environmental policies and practices are influenced by social, economic and political balances of power.

At the operational level of governance, the proposed framework proves particularly useful in showing that changes in one element of governance will force re-arrangements of all other elements, interconnections and results. This agrees with Ostrom’s (2011: 61) perspective: ‘[…] changing the formal governance system alone is not a sufficient solution to difficult collective-action problems.’ Therefore, in order to introduce changes that can offer alternative solutions to complex irrigation governance issues, attention to the dynamics of power and effects on the outcomes of governance is vital. This contribution is important because it makes evident the usual causes of project failure, which are usually rooted in incomplete problem analysis and understanding of the underlying reasons of failure and success.

Contributions to expansion of the feminist political ecology approach

The integrative analysis in this research contributes to the strand of feminist scholarship dealing with intersectionality and water (Harris et al., 2015; Thompson, 2016). Critique of the insufficient balance between the three main elements of the FPE framework -*feminism, politics* and *ecology*, both conceptually (Najjar, 2015) and methodologically (Hanson and Buechler, 2015) were addressed in the construction of the conceptual framework in this thesis which conceptualised the irrigation system when managed collectively as a social-ecological system (SES). Bringing together relevant elements of the SES framework, such as the 'diagnostic method' (Ostrom, 2009)[256] made the agro-ecological dimension of the study more robust. Overall, this is useful because the type of issues associated with collective management of irrigation in areas of water scarcity are complex and interact at multiple levels and across scales.

The study also considered broader structural issues of power derived from institutions and their activities, and how they shape power relations. This was done by using the 'institutional analysis' of the social relations approach. Therefore, taking into account the social relations between people, relationships of people to resources and activities, and configurations of those relationships and institutions, provided a more nuanced and structured understanding of the irrigation management processes for a more operational assessment.

Contributions to scholarship on water governance

Findings in this study strongly suggest the need to understand and more comprehensively address the complex issues of social equality in access to resources; construction and maintenance of hydraulic infrastructure; functioning and performance of water institutions; and decision-making and participation in WUAs. By placing the analysis of interactions between technical and social dimensions at the centre of the study of water governance, this research has explicitly added a perspective that facilitates dialogue between water

---

[256] See Chapter 2, Section 2.5.1.

governance scholars, policy makers and practitioners. Truly constructive, interactive, and multidisciplinary dialogue between these actors remains needed in the field.[257]

Contributions to scholarship on women, gender and irrigation

An examination of the women, gender and irrigation literature for this study confirmed the 'general disconnect between scholarship on water policy and scholarship on gender' observed by Ray (2007: 423). The present study has further observed that many gender and irrigation studies often poorly connect to technical aspects of irrigation. This was addressed through the development of the integrative analytical approach. In addition, throughout the literature reviewed, it was observed that the gender and irrigation body of literature is largely based on case studies of traditional (village) irrigation systems. An important contribution of this study is the addition of empirical evidence from modernised irrigation schemes in regards to gender mechanisms of access to water, participation in water governance and decision-making, drivers of social differentiation and gender outcomes.

Research approach and methodology

A high diversity of data was required to test this integrative analytical framework. This diversity was pursued through two main approaches: first, designing a multi-case study in two countries, and second, by using a mixed-method research approach. This research strategy proved useful in capturing a broad variety of aspects from two contrasting countries. It allowed for the systematic collection and analysis of both qualitative and quantitative data (see Chapter 3 for reflections on the research approach use and challenges).[258]

It is useful to complement the use of this approach with other analytical tools, for example, the problem tree analysis method that visually maps problems at different scales. It allows the identification of where to implement actions with impact, and importantly, where it is convenient or possible to start working in the short-term. An example of problem tree analysis of the self-governance of water resources of Mendoza is presented in Appendix 19.

[257] See Chapter 6, Section 6.1.

[258] See Section 3.3.

9.5. Policy and practice implications

The role of gender integrative analyses in the irrigation management sector

By using the integrative analytical framework, this study has shown that an integrative gender analysis is vital to any study of the governance of natural resources as it uncovers previously unseen differences and inequalities based on gender. Unequal access to and participation in the use and management of natural resources have been identified as critical reasons for slow advances in overcoming gender-based constraints in development projects, poverty reduction and ecosystem sustainability (Cornwall, 2003; Meinzen-Dick et al., 2014; Meinzen-Dick et al., 2017). Moreover, the conclusions of a recent analysis of the United Nations' Sustainable Development Goals (SDGs) reflect on the incomplete definitions used to achieve gender equality in matters of access and use of natural resources, and warns that failing to consider difficulties and opportunities specific to women may jeopardise the SDGs' ambitious goals (Agarwal, 2018).

While at present, conducting gender assessments is a required standard practice in most internationally-funded NRM and agricultural development programmes, advances in gender equality seem not commensurate, which is at odds with the urgency of the problem. This can be explained by a number of interrelated factors that predispose incomplete problem analyses. These factors include short time frames available for gender studies, limited integration with the technical aspects of the project, and insufficient interdisciplinary cooperation in development projects. Failure to consider all dimensions and their interactions (social and technical) of irrigation agriculture, (e.g., type and access to water rights (Meinzen-Dick et al., 2014), technical and infrastructural characteristics of irrigation systems, social relations of power within the communities, and/or production and market constraints) conditions incomplete analysis and, *ergo*, ineffective policy response. The inevitable consequence is the worsening of gender inequalities.

Conceptually, 'gender' is often seen as unrelated to the 'technical' aspects of agriculture and NRM. Moreover, the irrigation water and hydraulic infrastructure operation and maintenance (O&M) sectors are overwhelmingly considered as male fields. This male over-representation has been also discussed for the irrigation water profession (Udas and Zwarteveen, 2010). Usually, gender analyses are entrusted to social or gender professionals, who very frequently lack the required expertise in agro-ecological sciences. In addition, women and men are typically viewed as homogeneous groups. This disregards how social relations of power define hierarchies of differences among the various groups of female and male resource users (Cornwall, 2003). Unfortunately, a frequently observed practice in development projects is to consider gender only formally or nominally in baseline studies and project designs. More often than not, in development practice an understanding of the intrinsic gender differences in securing access to resources, their use and decisions over those resources, and participation in their management is missing. It is noteworthy that these differences may not only lead to inequalities but also to complementarities (Kumar, 2015). However, regrettably, the audience of gender studies is often restricted to scholars and practitioners who already understand the importance of gender equality principles and practice.

The continued need of advancing gender equality polices in the irrigation governance sector

The study of gendered social relations and governance processes in the irrigation sector lays bare that well-informed gender integration policies in the traditionally male-dominated irrigation management sector are of high priority, but currently deficient. Findings in this study revealed how policy interventions are able to foster important changes in rather short periods of time.[259]

Policy implications arising from these findings focus on the need for: (1) support to overcome gendered cultural limitations to participation in the management and governance of irrigation systems; (2) explicit analysis of gender-specific effects of technical properties of irrigation development, and (3) special attention paid on the design of tailored extension programmes for female and male farmers.

The study of two diverging cases in terms of gender equality policies demonstrated that appropriate policy can also foster the necessary cultural changes that are required for greater equality. The case of Ethiopia shows that, despite restrictive social norms for women, the mainstreaming of gender policy across sectors and in particular in the agricultural sector, has resulted in more awareness of women's rights. In particular, younger generations of governmental staff appeared to be changing their understanding and attitude in the way they address development project design and implementation. By contrast, in the case of Mendoza, gender equality policies are weak and fragmented in the agricultural sector, and

[259] For examples, see Chapter 5, Section 5.6. and Chapter 6, Section 6.6.

are mainly limited to the family farming sector. The region lacks a gender policy framework for water resource management. The implications of the absence of a gender equality policy framework in the water sector are clearly seen: although Argentina has an overall legal framework based on equal rights with some advanced policies in terms of equality of gender, and open forms of discrimination due to gender, race, and class are penalised, the particular irrigation management sector continues to be adverse for women.

Nevertheless, these findings also suggest that having a policy framework in place is not sufficient to progress towards a more egalitarian society. For example, in Tigray, although an advanced gender equality policy framework exists, discrepancies persist between theory and practice of policy implementation, with insufficient institutional and human capacity for policy application and enforcement at local levels. Identifying gender differences and inequalities in conventional gender analysis is necessary but not sufficient. Rather, the implementation of integration of irrigation technical properties with gender analysis leads to comprehensive and effective policy and interventions when evaluated in the technical context of farming practice. For example, investment in irrigation infrastructure that reduces the physical workload in the practice of irrigation agriculture would particularly help women farming on their own. The explicit consideration of specific financial, knowledge and capacity development needs of different groups of women is vital.

Inclusive participation for the long endurance of WUAs

Even the successful resolution of 'technical' performance of WUAs and the introduction of gender equality policies will not be sufficient to ensure the long-term sustainability of the water management systems. The findings illustrate the need for three important policy revisions. First, WUAs need to acquire a broader scope for the long-term viability of the organisations and the SSIS. Findings in Chapter 7 showed that WUAs have the potential to undertake complementary activities to support their service delivery and financial viability. Interventions that support WUAs with the necessary elements to increase technical autonomy, to strengthen managerial and business skills, and to maintain collaborative work with the water administrations present opportunities for the state water sector and donor-funded projects.

Second, the overwhelming dependence of the water management system on the agricultural sector calls for territorial development policies that integrate water management with serious efforts in the urgent revitalisation of agriculture. In Mendoza, political will is needed to enhance the value of small-scale agriculture as a critically important livelihood strategy, particularly amongst the youth who are massively leaving the agricultural sector. Also, critically important is the coordination of the different water right holders that are members of WUAs (i.e. urban, agricultural, recreational, and industrial water users as well as energy producers and the mining sector) by establishing efficient participation approaches and incentives. In Tigray, expansion of the hydraulic infrastructure based on sound technical advice and bottom-up participation of WUAs from the on-set of projects is vital. There is a fundamental need for an integrated effort to increase the agricultural production value while at the same time improve small-scale farming operations and productivity, cost-effective use of increasingly expensive inputs -including irrigation water-, and enhancement of market access.

Third, there is a need for more inclusive mechanisms of participation in WUAs. Most frequently, not all actors directly or indirectly affecting and being affected by water resource management are represented in the governance systems. Findings have shown that WUAs are the single local level institutions with the highest representation of smallholder irrigation farmers in the territory, however, a large number of water users, e.g., women farmers, in particular those who are not WUA members in their own right, sharecroppers and landless water users are excluded from official decision-making spaces. Strengthening WUAs as catalysts of rural development constitutes both an important opportunity and an urgent need for the viability and survival of small-scale irrigation systems. This demands more inclusive mechanisms of participation with explicit support to the under-represented groups of users. A broader stakeholder platform of discussion regarding the current and interconnected water challenges is lacking in both governance systems.

The need for the explicit inclusion of more women in management, decision-making and leadership in the irrigation sector

The findings in this study clearly indicate that there is an urgent need for purposively improving opportunities for women's participation in the irrigation management sector. There are two fundamentally important aspects that need be improved in order to deliver inclusive participation and sustainable resource management. First, it is necessary to quantitatively increase the participation of women. There is evidence that increasing the number of women in a communal group of resource management has a positive effect on the participation of other women who become more confident to take part and voice their needs (Agarwal, 2010; 2015). Second, there is a need to improve the capacity of women to lead effectively by providing appropriate training and capacity building. Those women who are willing to lead should be able to acquire the necessary skills to effectively exercise those leadership positions. These two aspects can be addressed through imposing rules of entries (quotas), but only if they are complemented with acquiring technical knowledge; awareness of the importance of more women in leadership, and establishing specific conditions to facilitate the participation of women.

Nevertheless, a genuine inclusive participation in irrigation management requires that persistent asymmetrical gendered social structures and social hierarchies are challenged (Upadhyay, 2003; Harris, 2006; Vera Delgado and Zwarteveen, 2017). In order to allow more women with more meaningful participation in irrigation, there is a need to change the cultural tradition of considering irrigation as a matter of male expertise and responsibility. In the traditionally male-dominated water institutions, there is a clear need to educate water management officials to recognise the capacity of women in technical and management positions in water governance. More women need to be trained and employed in water agencies at higher hierarchical levels. To place more women in these positions will be only possible through cultural change fostered by explicit and effective policy frameworks. However, the willingness to increase participation of women must be continuously supported, most importantly, at the local administration and irrigation scheme levels. Otherwise, participation of women appears to be hard to consolidate, as shown by the examples from Mendoza.[260] Gender integration and equality policies in the water sector, are therefore imperative.

The need for making gender analyses operational and effectively linking research, policy and practice

In order to use the conceptual framework as a methodological approach, the analysis of outcomes, the identification of resulting gender differences and inequalities, and the policy implications and recommendations constitute the core elements of the integrative analysis and provide a useful tool for planning. Table 9.2 presents a summary of outcomes of irrigation water governance in communal SSIS as emerged from this study.

---

[260] See Chapter 8, Section 8.4.2.

Table 9.2 Summary of outcomes of the functioning of WUAs in communal SSIS

Outcomes	Gender differences and inequalities	Policy implications and recommendations
Security of access		
Legality	Less access to land rights implies less independent water rights for women.	- Formalisation of land and water rights - Transparency of water rights allocation - Explicit gender equality rules and policies
Reliability	Infrastructure and management faults as a source of inequality for all users. Unfair informal agreements may reduce security of access for women and other disadvantaged groups.	- Improvement in infrastructure maintenance - More efficient irrigation distribution systems
Affordability	Generalised low profitability of SSIS and/or less reliable access to water imply lower profits from agriculture, and in turn, less affordable access. Women usually incur in higher costs, therefore they cultivate less land, earn less income or leave the activity.	- Financial services adapted to specific needs of different groups of women - Formal support to improved agricultural practices
Physical capacity	More difficulties to perform irrigation maintenance work and cultural restrictions to perform certain tasks, often determine that women do not assert their water rights.	- Public investment in irrigation infrastructure that reduces drudgery: e.g. lined channels - Promotion of pressurised irrigation systems when feasible - Accommodating rules for disadvantaged users
Workload	Lower participation of women in WUAs' meetings and lower decision-making share.	- Improved extension services and gender equality awareness
Livelihood strategies	More difficult for women to find off-farm income opportunities. Small-scale irrigation may be a central livelihood strategy for women with limited off-farm options (provided water access is secured), or having farming as primary livelihood.	- Effective public support to small-scale farming - Cost-effective use of expensive irrigation water, e.g., high value crops, crop diversification, improved techniques
Autonomy	Lack of own land/water rights may limit autonomy of women and other disadvantaged groups. Incomes from irrigation allows certain groups a better life condition: e.g., avoiding exploitative working conditions; securing an income when other options are limited (e.g., people with disabilities or limited mobility); increasing household decision-making share.	- Formalisation of land rights - Explicit support to disadvantaged groups to access irrigation agriculture
Adaptive strategies	Those women already constrained, may be less able to adapt. Wider gaps between richer and poorer farmers. Not all smallholders able to stay in the sector.	- Improved extension services - Communal water saving irrigation systems and infrastructure (e.g. water reservoirs) - Explicit support to disadvantaged groups

Source: Developed by the author.

It seems advisable that researchers, project planners and implementers extend the 'usual' audience of their gender analyses to technical experts in irrigation agriculture, as they are typically not engaged in gender analysis of programmes. Consequently, the proposed framework provides a suitable platform for such integrative gender analyses, as it is also feasible to link the proposed framework with quantitative tools, used to collect and analyse gender-related data at the irrigation scheme level [261] and at the irrigation systems level[262], as well as with participatory research approaches (for examples, see Kumar, 2002; Cornwall, 2011).

The specific interest of this study focused on how livelihood processes are shaped by gender roles and relations emerging from water governance systems. However, the integrative analytical framework can be also used to analyse other elements of intersectionality, for instance, how a certain group is excluded from water access or management project benefits (e.g., landless; certain ethnic groups). It can be also used to simultaneously analyse other sources of differences and inequalities for groups, for example for women of different castes in India (Raha et al., 2013) or women of different education backgrounds in Egypt (Najjar, 2015). Operationally, this would mean adding as many columns as necessary in Table 9.2.

9.6. Considerations for further research

The linkages between increased participation of women and sustainability of irrigation systems

Although it is not straightforward to gauge the effects of increased participation of women in irrigation scheme management (as in both locations, like in many other countries as well, the participation of women in leading positions is extremely low), evidence from this study shows that women have a particularly strong interest in the long-term maintenance of irrigation infrastructure, cleaning canals and supporting fair distribution of water. This is noteworthy and deserves further investigation, as it suggests the certain long-term perspective often found in women in developing countries (Bennett et al., 2005; Perkins and Walker, 2015). From the selected illustrative cases of Tigray and Mendoza[263], the very few female-led WUAs were able to greatly improve the transparency of budget allocation, compared to their male predecessors, and they were the most active WUA leaders in fighting

[261] For example, the 'Irrigation Learning and Improvement Tool' (GILIT) (Lefore et al., 2017); the Gender Performance Indicator (Van Koppen, 2002), and the Women's Empowerment in Agriculture Index' (WEAI) (Alkire et al., 2013).
[262] For example, by using gender sensitive indicators for water as the ones proposed by the UNESCO World Water Assessment Programme (Miletto et al.. 2019).

[263] See Chapter 8, Section 8.4.2.

corruption in water distribution related issues. In addition, the idea of fair distribution of water and equitable enforcement of rules were recurrent issues discussed in interviews with women participants. In this regard, evidence is scant. D'Exelle et al. (2012) applied a behavioural experiment to women and men in water management and found that water might be shared equitably when women are in charge of water management. A systematic comparative longitudinal analysis of issues of fairness, technical management, and WUAs' performance of a larger and diverse sample of WUAs previously led by men and changed to female leadership would be extremely useful to more robustly establish whether a direct relationship between women in leadership of irrigation scheme management and sustainability exists.

Considerations of scale

The unit of analysis for this study has been the irrigation users' communities that manage the resource system(s) collectively: the WUA in the diverse forms taken in the different regions of the study. Reasons for this consideration were explained in Chapter 3. Furthering the scholarship in natural resource governance may require scaling up the analysis. This may be needed because:

- Resource systems can be several and combined. At the same time, resource mobilisation from/to the local level (territory) can happen across scales (Nightingale, 2015).
- Governance processes may mean a different number of community organisations (e.g, WUAs), a federation, a regional governance arrangement and/or coexistence of multiple governance systems. This is relevant, for example, when river basin and watershed approaches are used, where issues of overlapping administrative jurisdictions and governance systems are common.
- The analysis may require considerations of diverse time frames according to the policy frameworks, socio-cultural dynamics, and research needs.

Research approach and methodology

In comprehensive studies such as the one conducted, and especially when issues of intersectionality are addressed, there is a large amount of background information, including technical aspects regarding crop production; livelihood strategies; hydrological studies, and demographic and socio-economic databases. The original intention of this research was to use a GIS format to allow a visualisation of the relationships between water sources, soil types, productivity, farm sizes and socio-economic factors (Clifford and Valentine, 2003). Constraints in access to cartography and satellite images in both countries did not permit this. For future research, it is recommended to try this data management and analysis pathway. This would expand a robust visual description of gender roles and relations in irrigation when intersecting physical and socio-economic factors and seeking to establish spatial relationships. Spatially explicit tools in combination with the application of the integrative analytical framework might allow further insights into interactions between the social-ecological systems, and the dynamics of social relations.

9.7. Concluding remarks

The overall contribution of this study is an analysis of water governance with an integrative perspective of gender, social relations and livelihood processes towards the objectives of sustainable rural development and equality. A novel integrative gender-analytical framework was developed and applied to research NRM governance in two case studies of self-governed communal small-scale irrigation systems, from widely differing cultural and economic settings. Results support the notion that the management of a scarce natural resource for agricultural production must respond to a complex network of interactions that determine outcomes at multiple scales. In order to better understand how these outcomes are gendered, an analysis model was conceived that joins and extends three theoretical concepts (FPE, SES, and social relations framework). By explicit consideration of gender specific technical constraints to full participation in irrigation practice and governance (above and beyond those commonly recognised as consequences of gender and power relations), it opens up a practical perspective on policies and interventions in the development of SSIS that effectively and comprehensively addresses gender and other social asymmetries.

References

Aarnoudse, E., Closas, A. & Lefore, N. (2018). Water user associations: a review of approaches and alternative management options for sub-Saharan Africa. IWMI Working Paper 180. Colombo, Sri Lanka.

Adams, E. A., Juran, L. & Ajibade, I. (2018). 'Spaces of Exclusion' in community water governance: A Feminist Political Ecology of gender and participation in Malawi's Urban Water User Associations. *Geoforum,* **95**, 133-142.

Adams, W., Watson, E. & Mutiso, S. (1997). Water, rules and gender: Water rights in an indigenous irrigation system, Marakwet, Kenya. *Development and Change,* **28(4)**, 707-730.

Admasu, A., Kiros, M. & Memhur, A. (2011). Baseline survey of Endamehoni woreda of Tigray Region. *Growth and Tranformation Plan (GTP) for the Government of Ethiopia.* Mekele, Ethiopia.

Agarwal, B. (1994). *A field of one's own: Gender and land rights in South Asia.* UK: Cambridge University Press.

Agarwal, B. (1997). "Bargaining" and gender relations: Within and beyond the household. *Feminist Economics,* **3(1)**, 1-51.

Agarwal, B. (2001). Participatory exclusions, community forestry, and gender: An analysis for South Asia and a conceptual framework. *World development,* **29(10)**, 1623-1648.

Agarwal, B. (2010). Does women's proportional strength affect their participation? Governing local forests in South Asia. *World Development,* **38(1)**, 98-112.

Agarwal, B. (2015). The power of numbers in gender dynamics: Illustrations from community forestry groups. *The Journal of Peasant Studies,* **42(1)**, 1-20.

Agarwal, B. (2018). Gender equality, food security and the sustainable development goals. *Current Opinion in Environmental Sustainability,* **34**, 26-32.

Agarwal, B. & Herring, R. (2013). *Food security, productivity and gender inequality*. Oxford University Press New York.

Agrawal, A. & Ostrom, E. (2001). Collective Action, Property Rights, and Decentralization in Resource Use in India and Nepal. *Politics & Society,* **29(4)**, 485-514.

Ahlers, R. & Zwarteveen, M. (2009). The water question in feminism: Water control and gender inequities in a neo-liberal era. *Gender, Place & Culture,* **16(4)**, 409-426.

Akter, S., Rutsaert, P., Luis, J., Htwe, N. M., San, S. S., Raharjo, B. & Pustika, A. (2017). Women's empowerment and gender equity in agriculture: A different perspective from Southeast Asia. *Food Policy,* **69**, 270-279.

Aladuwaka, S. & Momsen, J. (2010). Sustainable development, water resources management and women's empowerment: the Wanaraniya Water Project in Sri Lanka. *Gender & Development,* **18(1)**, 43-58.

Alkire, S., Meinzen-Dick, R., Peterman, A., Quisumbing, A., Seymour, G. & Vaz, A. (2013). The women's empowerment in agriculture index. *World Development,* **52**, 71-91.

Allo, A. K. (2018). The power of Ethiopia´s gender-balanced cabinet. *Al Jazeera*, 19 October 2018, URL: https://www.aljazeera.com/indepth/opinion/power-ethiopia-gender-balanced-cabinet-181019110930577.html [14 February 2019].

Anderies, J. M., Janssen, M. A. & Ostrom, E. (2004). A framework to analyze the robustness of social-ecological systems from an institutional perspective. *Ecology and Society,* **9(1)**, 18.

Arnstein, S. R. (1969). A ladder of citizen participation. *Journal of the American Institute of planners,* **35(4)**, 216-224.

Athukorala, K. (1996). The need for gender analysis in strategic planning for effective water management in Sri Lanka. *International Journal of Water Resources Development,* **12(4)**, 447-460.

Baland, J.-M. & Platteau, J.-P. (1999). The ambiguous impact of inequality on local resource management. *World Development,* **27(5)**, 773-788.

Bandyopadhyay, S., Shyamsundar, P. & Xei, M. (2007). *Yield impact of irrigation management transfer: story from the Philippines.* Policy Research Working Paper 4298. Washington.The World Bank.

Bastidas, E. (2005). Women and water in the Northern Ecuadorian Andes. *In:* Bennett, V., Dávila-Poblete, S. & Rico, M. N. (eds.) *Opposing currents: The politics of water and gender in Latin America.* Pittsburgh, USA: University of Pittsburgh Press.

Beccar, l., Boelens, R. & Hoogendam, P. (2002). Water rights and collective action in community irrigation *In:* Boelens, R. & Hoogendam, P. (eds.) *Water righst and empowerment.* Assen, The Netherlands: Koninklijke Van Gorcum.

Bennett, V., Dávila-Poblete, S. & Rico, N. (2005). *Opposing currents: The politics of water and gender in Latin America.* Pittsburgh, USA: University of Pittsburgh Press.

Bennett, V., Dávila-Poblete, S. & Rico, N. (2008). Water and Gender: The unexpected connection that really matters. *Journal of International Affairs,* **61(2)**, 107.

Berhane, T. & Miruts, G. (2015). Rural Women Land Use Right in Tigray Regional State: The Case of Kafta Humra Woreda. *Journal of Culture, Society and Development,* **10(1)**, 47-62.

Bezabih, M., Holden, S. & Mannberg, A. (2016). The role of land certification in reducing gaps in productivity between male- and female- owned farms in rural Ethiopia. *The Journal of Development Studies,* **52(3)**, 360-376.

Biemer, P. P. & Lyberg, L. E. (2003). *Introduction to survey quality.* John Wiley & Sons.

Boelens, R. & Doornbos, B. (2001). The battlefield of water rights: Rule making amidst conflicting normative frameworks in the Ecuadorian highlands. *Human Organization,* **60(4)**, 343-355.

Boelens, R. & Hoogendam, P. (2002). *Water rights and empowerment.* Assen, The Netherlands: Koninklijke Van Gorcum.

Boelens, R. & Vos, J. (2014). Legal pluralism, hydraulic property creation and sustainability: the materialized nature of water rights in user-managed systems. *Current Opinion in Environmental Sustainability,* **11(0)**, 55-62.

Boelens, R. & Zwarteveen, M. (2002). Gend dimensions in water control in Andean irrigation. *In:* Boelens, R. & Hoogendam, P. (eds.) *Water rights and empowerment.* Assen, pp.75-109 The Netherlands: Koninklijke Van Gorcum.

Boserup, E. (1970). *Woman's role in economic development.* New York: St. Martin's Press, Inc.

Bossenbroek, L. & Zwarteveen, M. (2014). Irrigation Management in the Pamirs in Tajikistan: A Man's Domain? *Mountain Research and Development,* **34(3)**, 266-275.

Brignardello, M. (2015). *Reestructuración, calidad y trabajo. El caso de la pequeña y mediana producción vitivinícola de Mendoza.* Tesis de Maestría, FLACSO Argentina.

Brisbois, M. C. & de Loë, R. C. (2016). Power in collaborative approaches to governance for water: A systematic review. *Society & Natural Resources,* **29(7)**, 775-790.

Bryman, A. (2012). *Social research methods.* Oxford: UK: Oxford University Press.

Budds, J. (2008). Whose scarcity? The hydrosocial cycle and the changing waterscape of La Ligua river basin, Chile. *In:* Goodman, M., Boykoff, M. & K., E. (eds.) *Contentious Geographies: Environmental knowledge, meaning, scale,* pp.59-78. Oxon: Routledge.

Buechler, S. (2015). Climate-water challenges and gendered adaptation strategies in Rayón, a riparian community in Sonora, Mexico. *In:* Buechler, S. & Hanson, A. M. S. (eds.) *A Political Ecology of Women, Water and Global Environmental Change*, pp.99-177. UK: Taylor & Francis.

Buechler, S. & Hanson, A.-M. S. (2015). *A political ecology of women, water and global environmental change.* UK: Routledge.

Centrone, F., Mosso, A., Busato, P. & Calvo, A. (2017). Water gender indicators in agriculture: A study of horticultural farmer organizations in Senegal. *Water,* **9(12)**, 972.

Chancellor, F. (2005). Enabling women to participate in African smallholder irrigation development and design. *In:* Coles, A. & Wallace, T. (eds). *Gender, water and development*, pp.155-72. Oxford: Berg.

Cleaver, F. (1998). Choice, complexity, and change: Gendered livelihoods and the management of water. *Agriculture and Human Values,* **15(4)**, 293-299.

Cleaver, F. & Elson, D. (1995). *Women and water resources: Continued marginalisation and new policies.* London: International Institute for Environment and Development

Cleaver, F. & Hamada, K. (2010). 'Good' water governance and gender equity: a troubled relationship. *Gender & Development,* **18(1)**, 27-41.

Clement, F. (2012). Literature review: Gender and water management organisations in Bangladesh. *G3: Water governance and community based management.* Colombo, Sri Lanka: IWMI.

Clifford, N. & Valentine, G. (2003). *Key methods in geography.* London, UK: Sage.

Collard, R.-C., Harris, L. M., Heynen, N. & Mehta, L. (2018). The antinomies of nature and space. *Environment and Planning E: Nature and Space,* **1(1-2)**, 3-24.

Cornwall, A. (2003). Whose voices? Whose choices? Reflections on gender and participatory development. *World development,* **31(8)**, 1325-1342.

Cornwall, A. (2011). *The participation reader.* London: Zed Books.

Cornwall, A., Edström, J. & Greig, A. (2011). Introduction: Politicizing Masculinities in Development. *Men and Development–Politicising Masculinities, London: Zed Books*.

Cornwall, A. & Edwards, J. (2015). Introduction: Beijing+ 20–where now for gender equality? *IDS Bulletin,* **46(4)**, 1-8.

Cornwall, A. & Rivas, A.-M. (2015). From 'gender equality and 'women's empowerment' to global justice: reclaiming a transformative agenda for gender and development. *Third World Quarterly,* **36(2)**, 396-415.

Cotula, L. (2012). The international political economy of the global land rush: A critical appraisal of trends, scale, geography and drivers. *Journal of Peasant Studies,* **39(3-4)**, 649-680.

Creswell, J. W. (2013). *Research design: Qualitative, quantitative, and mixed methods approaches.* 4th ed.: Sage publications.

Crow, B. & Sultana, F. (2002). Gender, Class, and Access to Water: Three Cases in a Poor and Crowded Delta. *Society & Natural Resources,* **15(8)**, 709-724.

CSA (2012). Ethiopia Demographic and Health Survey (EDHS) 2011 *In:* CSA (ed.). Addis Ababa.

CSA. (2013). *Population Projection of Ethiopia for All Regions at Wereda Level from 2014 – 2017*. URL: http://www.csa.gov.et/images/general/news/pop_pro_wer_2014-2017_final [15.09.2015].

CSA & World Bank (2017). LSMS—Integrated Surveys on Agriculture Ethiopia Socioeconomic Survey (ESS) 2015/2016. *In:* Central Statistical Agency of Ethiopia in Collaboration with the National Bank of Ethiopia and the World Bank (ed.). Addis Ababa.

CSA and ICF International Calverton (2011). Ethiopia Demographic and Health Survey 2011 *In:* Central Statistical Agency (ed.). Addis Ababa, Ethiopia and Maryland, US

D'Exelle, B., Lecoutere, E. & Van Campenhout, B. (2012). Equity-efficiency trade-offs in irrigation water sharing: Evidence from a field lab in rural Tanzania. *World Development,* **40(12)**, 2537-2551.

DACC. (2017). *Agricultura y Contingencias Climáticas*. URL: http://www.contingencias.mendoza.gov.ar/web1/gestion_del_riesgo_agricola/emergencia.html [05/12/2017].

De Boer, C., Vinke-de Kruijf, J., Özerol, G. & Bressers, H. T. A. (2013). Water Governance, Policy and Knowledge Transfer: International Studies on Contextual Water Management. Hoboken: Taylor and Francis.

de Fraiture, C. & Giordano, M. (2014). Small private irrigation: A thriving but overlooked sector. *Agricultural Water Management,* **131**, 167-174.

Deere, C. D., Oduro, A. D., Swaminathan, H. & Doss, C. (2013). Property rights and the gender distribution of wealth in Ecuador, Ghana and India. *Journal of economic inequality,* **11(2)**, 249-265.

DEIE (2016). Informe Anual: Encuesta condiciones de vida Mendoza. Año 2016. *In:* Dirección de Estadísticas e Investigaciones Económicas (ed.). Mendoza.

DEIE. (2017). *Información Municipal*. URL: http://www.deie.mendoza.gov.ar/#!/ [03/12/2017].

Deininger, K., Ali, D. A., Holden, S. & Zevenbergen, J. (2008). Rural land certification in Ethiopia: Process, initial impact, and implications for other African countries. *World Development,* **36(10)**, 1786-1812.

Dewan, C., Buisson, M.-C. & Aditi, M. (2014). The Imposition of Participation? The Case of Participatory Water Management in Coastal Bangladesh. *Water Alternatives,* **7(2)**, 342-366.

DFID (2003). Tools for Development. A handbook for those engaged in development activity. UK: Department for International Development (DFID).

DGI (2014). Programa Integral Sistema Cacique Guaymallén. *In:* FAO-DGI-PROSAP-Banco Mundial (ed.). Mendoza, Argentina: Departamento General de Irrigación.

DGI (2015). Balance Hídrico Tunuyán Inferior [Water demand and supply analysis Lower Tunuyán River Basin]. Presentación en Boletín Oficial: 18/07/2016. Mendoza, Argentina: Departamento General de Irrigación.

DGI (2016). Balance Hídrico Río Mendoza y Cuenca del Río Mendoza [Water demand and supply analysis Mendoza River Basin]. Presentación en Boletín Oficial: 10/01/2017. Mendoza, Argentina: Departamento General de Irrigación.

DGI (2018). *Riego Acordado [Agreed irrigation]*. URL: http://www.irrigacion.gov.ar/riegoacordado/ [26 October 2018].

DGI (2019). *Departamento General de Irrigación [General Irrigation Department]*. URL: http://www.irrigacion.gov.ar/dgi/es [02 February 2019].

Dokken, T. (2015). Allocation of land tenure rights in Tigray: How large is the gender bias? *Land Economics,* **91(1)**, 106-125.

Domènech, L. (2015). Improving irrigation access to combat food insecurity and undernutrition: A review. *Global Food Security,* **6**, 24-33.

Ebato, M. & Van Koppen, B. (2005). Gender relations and management of multiple water use system in Adidaero Watershed, Tigray region in Northern Ethiopia. International Research Workshop on 'Gender and Collective Action, Chiang Mai, Thailand, 17-21 Oct 2005.

Elmhirst, R. (2015). Feminist political ecology. *The Routledge Handbook of Gender and Development.* Routledge.

Fabinyi, M., Evans, L. & Foale, S. J. (2014). Social-ecological systems, social diversity, and power: Insights from anthropology and political ecology. *Ecology and Society*, **19(4)**, 28.

FAOSTAT. (2017). *FAO Statistics*. URL: http://www.fao.org/statistics/en/ [28/11/2017].

FAOSTAT. (2019). *FAO Statistics*. URL: http://www.fao.org/faostat/en/#data/OE [17/06/2019].

Franks, T. & Cleaver, F. (2007). Water governance and poverty: A framework for analysis. *Progress in Development Studies*, **7(4)**, 291-306.

Franks, T., Cleaver, F., Maganga, F. & Hall, K. (2013). Water governance and livelihoods: Outcomes for smallholders on the Usangu plains, Tanzania. *Water Resources and Rural Development*, **1-2**, 1-16.

Garces-Restrepo, C., Vermillion, D. & Muoz, G. (2007). Irrigation management transfer. Worldwide efforts and results. *In:* IWMI (ed.). Rome, Italy: FAO.

Gebrehiwot, N., Mesfin, K. & Nyssen, J. (2015). Small-scale Irrigation: The Driver for Promoting Agricultural Production and Food Security (The Case of Tigray Regional State, Northern Ethiopia). *Irrigation & Drainage Systems Engineering*, **4(2)**, 1000141.

Giarracca, N. & Del Pozo, N. (2005). La lucha por los derechos del agua en Tucumán. Transnacionales y mujeres en la protesta social. *GIARRACCA, Norma y Miguel Teubal, coord, El campo argentino en la encrucijada. Estrategias y resistencias sociales, ecos en la ciudad. Buenos Aires, Alianza*.

Gibbs, G. R. (2002). *Qualitative data analysis: Explorations with NVivo.* Open University.

Gimelli, F. M., Bos, J. J. & Rogers, B. C. (2018). Fostering equity and wellbeing through water: A reinterpretation of the goal of securing access. *World Development*, **104**, 1-9.

Gobierno de Mendoza (1996). Ley 6.405. Administración y preservación de canales, hijuelas y desagües de riego de la provincia. Mendoza: Boletín Oficial (21/08/1996).

Gragasin, M., Maruyama, A., Marciano, E., Fujiie, M. & Kikuchi, M. (2005). Irrigators' association and farm productivity: A comparative study of two Philippne irrigation systems. *The Japanese Journal of Rural Economics*, **7**, 1-17.

GWP (2019). IWRM Toolbox. URL: https://www.gwp.org/en/learn/iwrm-toolbox/Institutional_Arrangements/ [6 March 2019].

Habtu, S. & Yoshinobu, K. (2006). Traditional irrigation management in Betmera-Hiwane, Ethiopia: The main peculiarities for the persistence of irrigation practices. *Journal of Mountain Science*, **3(2)**, 139-146.

Hagos, M. A. (2010). *Groundwater flow modelling assisted by GIS and RS Techniques (Raya Valley - Ethiopia).* Master of Science in Geo-information Science and Earth Observation, International Institute for Geo-information Science and Earth Observation

Haile, G. G. & Kasa, A. K. (2015). Irrigation in Ethiopia: A review. *Academia Journal of Agricultural Research* **3(10)**, 264-269.

Haileslassie, A., Hagos, F., Agide, Z., Tesema, E., Hoekstra, D. & Langan, S. (2016). Institutions for irrigation water management in Ethiopia: Assessing diversity and service delivery. *LIVES Working Paper.* Nairobi, Kenya: International Livestock Research Institute (ILRI).

Hailu Kahsay, G. (March 2018). *RE: Researcher at Mekele University. Personal communication.*

Hanson, A. & Buechler, S. (2015). Introduction: Towards a feminist political ecology of women, global change, and vulnerable waterscapes. *In:* Buechler, S. & Hanson, A. M. S. (eds.) *A Political Ecology of Women, Water and Global Environmental Change*, pp.1-16. Oxon, UK: Taylor & Francis.

Harris, L. (2005) Negotiating inequalities: Democracy, Gender, and Politics of Difference in Water User Groups of Southeastern Turkey. *In:* Ashgate A and Aldershot U (eds) *Environmentalism in Turkey*, pp. 185-200. Aldershot, UK and Burlington, VA, USA.

Harris, L. (2006). Irrigation, gender, and social geographies of the changing waterscapes of southeastern Anatolia. *Environment and Planning D: Society and Space,* **24(2)**, 187-213.

Harris, L. (2008). Water Rich, Resource Poor: Intersections of Gender, Poverty, and Vulnerability in Newly Irrigated Areas of Southeastern Turkey. *World Development,* **36(12)**, 2643-2662.

Harris, L. (2009). Gender and emergent water governance: Comparative overview of neoliberalized natures and gender dimensions of privatization, devolution and marketization. *Gender, Place & Culture*, **16(4)**, 387.

Harris, L. (2015a). Hegemonic waters and rethinking natures otherwise. *In:* Harcourt, W. & Nelson, I. (eds.) *Practising Feminist Political Ecologies.* pp.157-181. London: Zed Books.

Harris, L. (2015b). Political ecologies of the state: Recent interventions and questions going forward. *Political Geography,* **58(1)**, 90-2.

Harris, L. (2015c). A quarter century of knowledge and change: Pushing feminism, politics, and ecololgy in new directions with feminist political ecology. *In:* Buechler, S. & Hanson, A. M. S. (eds.) *A Political Ecology of Women, Water and Global Environmental Change,* pp.xix-xxiii. Taylor & Francis.

Harris, L., Kleiber, D., Darkwah, A., Morinville, C. & Goldin, J. (2015). Intersections of gender and water: Comparative approaches to everyday gendered negotiations of water access in underserved areas of Accra, Ghana and Cape Town, South Africa. *Journal of Gender Studies,* **26(5)**, 561-582.

HEA (2007a). Draft Alaje –Ofla Highland Livelihood Zone. *In:* Household Economy Approach and Cost of the Diet (ed.) *Livelihood Profile Tigray Region, Ethiopia.* Save the Children, The Food Economy Group (FED), European Commission (ECHO).

HEA (2007b). Draft Raya Valley Sorghum and Teff Livelihood Zone. *In:* Household Economy Approach and Cost of the Diet (ed.) *Draft Livelihood Profile Tigray Region, Ethiopia.* Save the Children, The Food Economy Group (FED), European Commission (ECHO).

Holden, S. T. & Tilahun, M. (2017). Land Distribution in Northern Ethiopia from 1998 to 2016: Gender-dissagregated, Spatial and Intertemporal Variation. *Norwegian University of Life Sciences. Centre for Land Tenure Studies,* **3/2017**.

Hurlbert, M. A. & Montana, E. (2015). Dimensions of adaptive water governance and drought in Argentina and Canada. *Journal of Sustainable Development,* **8(1)**, p120.

ICTA (2015). Crop and livestock value chains in Endamehoni district, Ethiopia. *Africa Research In Sustainable Intensification for the Next Generation (Africa RISING).* International Centre for Tropical Agriculture.

IDR (2015a). Cuarto panorama agrícola 2015. Mendoza, Argentina: Instituto de Desarrollo Rural.

IDR (2015b). Primer panorama agrícola 2015 [First agricultural prospect 2015]. Mendoza, Argentina: Instituto de Desarrollo Rural.

IDR (2019a). *Maquinaria Agrícola [Agricultural Machinery]*. URL: https://www.idr.org.ar/maquinaria-rural/ [8 June 2019].

IDR (2019b). *Mujer Rural [Rural Woman]*. URL: https://www.idr.org.ar/mujer-rural/ [8 June 2019].

Imburgia, L. (2017). Rol de las organizaciones de regantes en el desarrollo productivo de Mendoza. Oportunidades y condiciones en el contexto de la descentralización hídrica. Mendoza, Argentina: Departamento General de Irrigación (DGI).

Imburgia, L. (2019). Irrigation and equality: A gender-analytical approach for water governance with examples from Ethiopia and Argentina. *Water Alternatives,* **12(2)**, 571-587.

Imburgia, L., Cardey, S., Osbahr, H. & Momsen, J. (unpublished manuscript-a). Inclusive participation, self-governance and sustainability: Current challenges and opportunities for women in leadership of communal irrigation systems. *Manuscript submitted for review*.

Imburgia, L., Osbahr, H. & Cardey, S. (unpublished manuscript-b). Rural development and the role of water users' associations in overcoming inequalities and sustaining small-scale irrigation agriculture. *Manuscript submitted for review*.

Imburgia, L., Osbahr, H., Cardey, S. & Momsen, J. (unpublished manuscript-c). Irrigation agriculture: A driver of social differentiation and an empowering livelihood option for rural women. *Manuscript submitted for review*.

INAM (2018). Plan de igualdad de oportunidades y derechos (PIOD) 2018-2020 [Plan of equal righs and opportunities]. *In:* Instituto Nacional de las Mujeres [Women National Council] (ed.). Buenos Aires, Argentina: Ministerio de Salud y Desarrollo Social

INDEC (2019). *Censo Nacional de Población, Hogares y Vivienda 2010*. URL: https://www.indec.gov.ar/nivel4_default.asp?id_tema_1=2&id_tema_2=41&id_tema_3=135 [08 March 2019].

InfoLeg (2017). *Trabajo Agrario*. URL: http://servicios.infoleg.gob.ar/infolegInternet/anexos/190000-194999/192152/texact.htm [25 October 2017].

Jackson, C. (1998). Gender, irrigation, and environment: Arguing for agency. *Agriculture and Human Values,* **15(4)**, 313-324.

Joy, K. J., Kulkarni, S., Roth, D. & Zwarteveen, M. (2014). Re-politicising water governance: exploring water re-allocations in terms of justice. *Local Environment,* **19(9)**, 954-973.

Kabeer, N. (1994). *Reversed realities: Gender hierarchies in development thought.* London, UK: Verso.

Kabeer, N. (1999). Resources, agency, achievements: Reflections on the measurement of women's empowerment. *Development and Change,* **30(3)**, 435-464.

Kabeer, N. (2005). Gender equality and women's empowerment: A critical analysis of the third millennium development goal 1. *Gender & Development,* **13(1)**, 13-24.

Kabeer, N. (2011). Between affiliation and autonomy: Navigating pathways of women's empowerment and gender justice in rural Bangladesh. *Development and Change,* **42(2)**, 499-528.

Kabeer, N. & Subrahmanian, R. (1996). *Institutions, relations and outcomes: Framework and tools for gender-aware planning.* UK: Institute of Development Studies.

Kamara, A., Van Koppen, B. & Magingxa, L. (2002). Economic viability of small-scale irrigation systems in the context of state withdrawal: the Arabie Scheme in the Northern Province of South Africa. *Physics and Chemistry of the Earth, Parts A/B/C,* **27(11-22)**, 815-823.

Kemerink, J., Méndez, L., Ahlers, R., Wester, P. & Van der Zaag, P. (2013). The question of inclusion and representation in rural South Africa: challenging the concept of water user associations as a vehicle for transformation. *Water Policy, 15(2), 2013; authors version (post-print).*

Koç, C. (2007). Assessing the financial performance of water user associations: A case study at Great Menderes basin, Turkey. *Irrigation and drainage systems,* **21(2)**, 61-77.

Koppen, B. C., Parthasarathy, R. & Safiliou, C. (2002). *Poverty dimensions of irrigation management transfer in large-scale canal irrigation in Andra Pradesh and Gujarat, India.* IWMI.

Kulkarni, S. (2011). Women and Decentralised Water Governance: Issues, Challenges and the Way Forward. *Economic & Political Weekly*.

Kumar, A. (2015). Complementing gender analysis methods. *Journal of Evidence-Informed Social Work*, 1-12.

Kumar, S. (2002). *Methods for community participation: A complete guide for practitioners.* Warwickshire, UK: Practical Action Publishing.

Łapniewska, Z. (2016). Reading Elinor Ostrom through a Gender Perspective. *Feminist Economics,* **22(4)**, 129-151.

Lastarria-Cornhiel, S., Behrman, J., Meinzen-Dick, R. & Quisumbing, A. (2014). Gender equity and land: Toward secure and effective access for rural women. *In:* Quisumbing, A. R., Meinzen-Dick, R., Raney, T. L., Croppenstedt, A., Behrman, J. A. & Peterman, A. (eds.) *Gender in Agriculture.* Springer Netherlands.

Lautze, J., de Silva, S., Giordano, M. & Sanford, L. (2014). Water Governance. *Key Concepts in Water Resource Management: A Review and Critical Evaluation*, 25.

Lecoutere, E. (2011). Institutions under construction: Resolving resource conflicts in Tanzanian irrigation schemes. *Journal of Eastern African Studies*, **5(2)**, 252-273.

Lefore, N., Weight, E. & Mukhamedova, N. (2017). Improving gender equity in irrigation: Application of a tool to promote learning and performance in Malawi and Uzbekistan. Colombo, Sri Lanka: International Water Management Institute (IWMI).

Leslie McCall (2005). The Complexity of Intersectionality. *Signs,* **30(3)**, 1771-1800.

Longhurst, R. (2003). Semi-structured interviews and focus groups. *In:* Clifford, N. & Valentine, G. (eds.) *Key Methods in Geography,* pp.117-132. London, UK: Sage Publications.

Loyarte, M. M. G., Menenti, M. & Diblasi, Á. M. (2009). Mapa bioclimático para las Travesías de Mendoza (Argentina) basado en la fenología foliar. *Rev la Fac Ciencias Agrar,* **41(1)**, 105-122.

Lyon, S., Bezaury, J. A. & Mutersbaugh, T. (2010). Gender equity in fairtrade–organic coffee producer organizations: Cases from Mesoamerica. *Geoforum,* **41(1)**, 93-103.

March, C., Smyth, I. & Mukhopadhyay, M. (1999). *A guide to gender-analysis frameworks.* Oxford: Oxfam.

Marre, M. (2007). *El principio de descentralización como base de la administración del agua de riego en la provincia de Mendoza : hacia la búsqueda de sustentabilidad del sistema mediante el fortalecimiento de la autarquía y la capacidad de gestión de los organismos de usuarios.* Master, FLACSO.

Marre, M. (2010). *El agua no es suficiente: Irrigación y administradores del agua, una descentralización que retrocede.* Argentina: EON.

Masanyiwa, Z. S., Niehof, A. & Termeer, C. J. (2014). Gender perspectives on decentralisation and service users' participation in rural Tanzania. *The Journal of Modern African Studies,* **52(01)**, 95-122.

McGinnis, M. D. & Ostrom, E. (2014). Social-ecological system framework: Initial changes and continuing challenges. *Ecology and Society,* **19(2)**, 30.

Mehta, L. (2007). Whose scarcity? Whose property? The case of water in western India. *Land Use Policy,* **24(4)**, 654-663.

Mehta, L., Huff, A. & Allouche, J. (2019). The new politics and geographies of scarcity. *Geoforum,* **101**, 222-230.

Mehta, L. & Langmeier, D. (2019). The rights to water and food. *In:* Sultana, F. & Loftus, A. (eds.) *Water Politics: Governance, Justice and the Right to Water,* pp.68-83. London: Routledge.

Mehta, L., Veldwisch, G. J. & Franco, J. (2012). Introduction to the special issue: water grabbing? Focus on the (re) appropriation of finite water resources. *Water Alternatives,* **5(2)**, 193-207.

Meinzen-Dick, R. (1997). Farmer participation in irrigation – 20 years of experience and lessons for the future. *Irrigation and Drainage Systems,* **11(2)**, 103-118.

Meinzen-Dick, R. (2007). Beyond panaceas in water institutions. *Proceedings of the national Academy of sciences,* **104(39)**, 15200-15205.

Meinzen-Dick, R. (2014). Property rights and sustainable irrigation: A developing country perspective. *Agricultural Water Management,* **145**, 23-31.

Meinzen-Dick, R., Kovarik, C. & Quisumbing, A. R. (2014). Gender and sustainability. *Annual Review of Environment and Resources,* **39(1)**, 29.

Meinzen-Dick, R., Quisumbing, A., Doss, C. & Theis, S. (2017). Women's land rights as a pathway to poverty reduction: Framework and review of available evidence. *Agricultural Systems,* **172**, 72-82.

Meinzen-Dick, R. & Zwarteveen, M. (1998). Gendered participation in water management: Issues and illustrations from water users 'associations in South Asia. *Agriculture and Human Values,* **15(4)**, 337-345.

Meinzen-Dick, R. S., Brown, L. R., Feldstein, H. S. & Quisumbing, A. R. (1997). Gender, property rights, and natural resources. *World Development,* **25(8)**, 1303-1315.

Melesse, M. B., Dabissa, A. & Bulte, E. (2018). Joint Land Certification Programmes and Women's Empowerment: Evidence from Ethiopia. *The Journal of Development Studies,* **54(10)**, 1756-1774.

Merriam, S. B. (2009). *Qualitative Research : A Guide to Design and Implementation.* Somerset, USA: Wiley.

Miletto, M., Pangare, V. & Thuy, L. (2019). *Gender-responsive indicators for water assessment, monitoring and reporting (Vol. 1).* Paris: UNESCO Publishing.

Ministerio General de Escuelas (2015). Mapas de Mendoza. URL: www.mendoza.edu.ar [10 September 2015].

MoANR (2017). Gender equality strategy for Ethiopia's agriculture sector. *In:* Women Affairs Directorate of the MoANR (ed.). Addis Ababa: Ministry of Agriculture and Natural Resource Management.

Molden, D. (2007). *Water for food, water for life. A comprehensive assessment of water management in agriculture.* London: Earthscan, and Colombo: International Water Management Institute (IWMI).

Mommen, B., Humphries-Waa, K. & Gwavuya, S. (2017). Does women's participation in water committees affect management and water system performance in rural Vanuatu? *Waterlines,* **36(3)**, 216-232.

Momsen, J. (2017). Gender and rural migration in Mexico and the Caribbean. *In:* Bock B.B. and Shortall, S. (ed.) *Gender and Rural Globalization: International Perspectives on Gender and Rural Development,* pp.77-88. UK: CABI.

Momsen, J. H. (2010). *Gender and development.* 2nd ed. London: Routledge.

Montaña, E. & Fernández, D. (2010). Situación de los diferentes sectores y subsectores de la economía mendocina. Diagnóstico de la economía provincial. *In:* Ministerio de Economía y Finanzas Públicas (ed.) *Proyecto Fortalecimiento Institucional para el diseño del Plan Estratégico de Desarrollo de la Provincia de Mendoza.* Mendoza, Argentina: Secretaría de Medio Ambiente Provincia de Mendoza.

Montes de Oca, A. (2018). ¿Se acaba el campo frutihortícola en Mendoza? *Mendoza Post*, 6 January, URL: http://www.mendozapost.com/nota/79981-se-acaba-el-campo-frutihorticola-en-mendoza/.

Morabito, J., Bos, M., Vos, S. & Brouwer, R. (1997). The quality of service provided by the irrigation department to the users associations, Tunuyan System, Mendoza, Argentina. *Irrigation and Drainage Systems,* **12(1)**, 49-65.

Morales, M. C. & Harris, L. (2014). Using Subjectivity and Emotion to Reconsider Participatory Natural Resource Management. *World Development,* **64(0)**, 703-712.

Morinville, C. & Harris, L. (2014). *Participation, politics and panaceas: exploring the possibilities and limits of participatory urban water governance in Accra, Ghana.* University of British Columbia.

Morton-Williams, J. (1985). Making qualitative research work—aspects of administration. *Applied qualitative research,* 27-44.

Moser, C. O. (1992). Adjustment from below: Low-income women, time and the triple role in Guayaquil, Ecuador. *In:* Afshar, H., Dennis C. (ed.) *Women and adjustment policies in the Third World,* pp.699-708. London: Palgrave Macmillan.

Moser, C. O. (1993). *Gender planning and development: Theory, practice and training.* New York: Routledge.

MoWR (2014). Water resource hydrometeorology. Raya pressurised irrigation project. Feasibility study draft. Federal Democratic Republic of Ethiopia: Addis Ababa.

Muchara, B., Ortmann, G., Wale, E. & Mudhara, M. (2014). Collective action and participation in irrigation water management: A case study of Mooi River Irrigation Scheme in KwaZulu-Natal Province, South Africa. *Water SA,* **40(4)**, 699-708.

Mustafa, D., Altz-Stamm, A. & Scott, L. (2016). Water User Associations and the Politics of Water in Jordan. *World Development,* **79**, 164-176.

MWIE (2000). Ethiopian Water Resources Management Proclamation Nº 197/2000. *In:* Council of Ministers Ethiopian Water Resources Management (ed.) *66.* Addis Ababa: Federal Negarit Gazeta No. 25, 5th year, 9 March 2000.

MWIE (2014). Irrigation Water Users' Associations Proclamation Nº 841/2014. *In:* Council of Ministers Ethiopian Water Resources Management (ed.). Addis Ababa: Federal Negarit Gazeta No. 74, 20th year, 26th September, 2014.

Najjar, D. (2015). Women's contributions to climate change adaptation in Egypt's Mubarak Resettlement Scheme through cactus cultivation and adjusted irrigation. *In:* Buechler, S. & Hanson, A. M. S. (eds.) *A Political Ecology of Women, Water and Global Environmental Change,* pp.141-161. Oxon, UK: Taylor & Francis.

Namara, R. E., Hanjra, M. A., Castillo, G. E., Ravnborg, H. M., Smith, L. & Van Koppen, B. (2010). Agricultural water management and poverty linkages. *Agricultural Water Management,* **97(4)**, 520-527.

Narain, V. (2014). Whose land? Whose water? Water rights, equity and justice in a peri-urban context. *Local Environment,* **19(9)**, 974-989.

Nation, M. L. (2010). Understanding women's participation in irrigated agriculture: A case study from Senegal. *Agriculture and Human Values,* **27(2)**, 163-176.

Nightingale, A. (2015). Challenging the romance with resilience: Communities, scale and climate change. *In:* Harcourt, W. & Nelson, I. (eds.) *Practising Feminist Political Ecologies,* pp.182-208. London: Zen Books.

Oates, N., Hisberg, A., Rodríguez Ros, J., Solomon, H., Ludi, E., Marlet, S. & Jamin, J. Y. (2017). The Implications of state intervention for self-governed irrigation schemes: Insights from Tigray, Ethiopia. *Irrigation and Drainage*.

OECD (2018). *Implementing the OECD Principles on Water Governance.* Paris: OECD Publishing.

Ongsakul, R., Resurreccion, B. & Sajor, E. (2012). Normalizing masculinities in water bureaucracy in Thailand. *International Journal of Public Administration,* **35(9)**, 577-586.

Ortega-Reig, M., Sanchis-Ibor, C., Palau-Salvador, G., García-Mollá, M. & Avellá-Reus, L. (2017). Institutional and management implications of drip irrigation introduction in collective irrigation systems in Spain. *Agricultural water management,* **187**, 164-172.

Ostrom, E. (1993). Design principles in long-enduring irrigation institutions. *Water Resources Research,* **29(7)**, 1907-1912.

Ostrom, E. (2007). A diagnostic approach for going beyond panaceas. *Proceedings of the National Academy of Sciences,* **104(39)**, 15181-15187.

Ostrom, E. (2009). A General Framework for Analyzing Sustainability of Social-Ecological Systems. *Sciences **325(5939)**: 419-422.*

Ostrom, E. (2011). Reflections on "Some unsettled problems of irrigation". *The American Economic Review,* **101(1)**, 49-63.

Ostrom, E., Janssen, M. A. & Anderies, J. M. (2007). Going beyond panaceas. *Proceedings of the National Academy of Sciences,* **104(39)**, 15176-15178.

Palacios-Lopez, A., Christiaensen, L. & Kilic, T. (2015). How much of the labor in African agriculture is provided by women? *Food Policy,* **67(2017)**, 52-63.

Parker, H., Oates, N., Mason, N., Calow, R., Chadza, W. & Ludi, E. (2016). Gender, agriculture and water insecurity. Overseas Development Institute (ODI). London, UK.

Pattnaik, I., Lahiri-Dutt, K., Lockie, S. & Pritchard, B. (2018). The feminization of agriculture or the feminization of agrarian distress? Tracking the trajectory of women in agriculture in India. *Journal of the Asia Pacific Economy,* **23(1)**, 138-155.

Peet, R. & Hartwick, E. (2009). *Theories of development: contentions, arguments, alternatives.* New York: Guilford Press.

Perkins, P. E. E. & Walker, P. F. (2015). International partnerships of women for sustainable watershed governance in times of climate change. *A political ecology of women, water and global environmental change,* pp.144-166. London: Routledge.

Pinto, M. E. (2006). La administración y gestión del agua en Mendoza. *III Jornadas de Riego y Fertirriego, UNCuyo.* Mendoza, Argentina.

Pinto, M. E., Rogero, G. E. & Andino, M. M. (2006). *Ley de Aguas de 1884. Comentada y concordada [Water Law of 1884. Commented and agreed]*. 1a ed. Mendoza, Argentina: Irrigación Edita.

Radel, C., Schmook, B., McEvoy, J., MÉNdez, C. & Petrzelka, P. (2012). Labour Migration and Gendered Agricultural Relations: The Feminization of Agriculture in the Ejidal Sector of Calakmul, Mexico. *Journal of Agrarian Change,* **12(1)**, 98-119.

Raha, D., Osbahr, H. & Garforth, C. (2013). Does watershed development implemented through public private partnership empower women? a case review from Rajasthan, Western India. *Journal of Cleaner Production,* **60**, 18-33.

Rai, S. (2011). Gender and development: theoretical perspective. *In:* Visvanathan, N., Duggan, L., Wiegersma, N. & Nisonoff, L. (eds.) The *Women, Gender and Development Reader,* 2nd ed pp. 28-40. London: Zed Books.

Ray, I. (2007). Women, water, and development. *The Annual Review of Environment and Resources* **32**, 421-449.

Resurreccion, B. P., Jane Real, M. & Pantana, P. (2004). Officialising strategies: Participatory processes and gender in Thailand's water resources sector. *Development in Practice,* **14(4)**, 521-532.

Ribot, J. C. & Peluso, N. L. (2003). A Theory of Access. *Rural Sociology,* **68(2)**, 153-181.

Rocheleau, D., Thomas-Slayter, B. & Wangari, E. (1996). Gender and environment. *Feminist Political Ecology: Global Issues and Local Experiences*, 4-5.

SAF (2015). Sector Hortícola de Mendoza: Caracterización, rol de la agricultura familiar y propuestas de intervención. *In:* Secretaría de Agricultura Familiar (ed.). Mendoza, Argentina: Ministerio de Agroindustrias.

Saieg, L. (2017). Fruticultura: sólo quedan 100 productores de pera y manzana en la provincia. *Los Andes,* 2 December, URL: http://losandes.com.ar/article/view?slug=jkdasjfsdasdfasldfklas.

Saldías, C., Speelman, S. & Huylenbroeck, G. V. (2013). Access to Irrigation Water and Distribution of Water Rights in the Abanico Punata, Bolivia. *Society & Natural Resources,* **26(9)**, 1008.

Saurina, S., Faro, B. & Gómez, M. (2015). El rol de la mujer en la gestión integral de los recursos hídricos. *CONAGUA.* Paraná, Entre Ríos, Argentina: Instituto Nacional del Agua - Centro de Economía, Legislación y Administración del Agua.

Saxena, N. (1998). What is meant by People's Participation? *Journal of Rural Development - Hyderabad,* **17**, 111-114.

Schlager, E. & Ostrom, E. (1992). Property-Rights Regimes and Natural Resources: A Conceptual Analysis. *Land Economics,* **68(3)**, 249-262.

Scoones, I. (2009). Livelihoods perspectives and rural development AU - Scoones, Ian. *The Journal of Peasant Studies,* **36(1)**, 171-196.

Sellamuttu, S. S., Aida, T., Kasahara, R., Sawada, Y. & Wijerathna, D. (2014). How access to irrigation influences poverty and livelihoods: a case study from Sri Lanka. *The journal of development studies,* **50(5)**, 748-768.

Sen, A. (1999). *Development as freedom.* Oxford, UK: Oxford University Press.

Senanayake, N., Mukherji, A. & Giordano, M. (2015). Re-visiting what we know about irrigation management transfer: A review of the evidence. *Agricultural Water Management,* **149**, 175-186.

Severino, S. (2008). Proyecto: Rehabilitación del área de riego Constitución, Provincia de Mendoza. *In:* PROSAP (ed.). Mendoza: Ministerio de Agricultura, Ganadería y Pesca, Argentina.

Sojka, R. E., Bjorneberg, D. L. & Entry, J. (2002). Irrigation: An historical perspective.

Straschnoy, C. (2017). Ley de Paridad de Género. A partir de 2019, el 50% de las candidaturas deberán ser para mujeres. *TELAM*, 23/11/2017, URL: http://www.telam.com.ar/notas/201711/225486-ley-paridad-genero-aprobacion-congreso-mujeres.html.

Suhardiman, D., Giordano, M., Rap, E. & Wegerich, K. (2014). Bureaucratic reform in irrigation: A review of four case studies. *Water Alternatives,* **7(3)**, 442-463.

Sultana, F. (2009). Community and participation in water resources management: gendering and naturing development debates from Bangladesh. *Transactions of the Institute of British Geographers,* **34(3)**, 346-363.

Sultana, F. (2011). Suffering for water, suffering from water: Emotional geographies of resource access, control and conflict. *Geoforum,* **42(2)**, 163-172.

Sultana, F. (2015). Rethinking Community and Participation in Water Governance. *In:* Coles, A., Gray, L. & Momsen, J. (eds.) *The Routledge Handbook of Gender and Development.* pp. 261-272. London: Routledge.

Taddei, R. (2011). Watered-down democratization: modernization versus social participation in water management in Northeast Brazil. *Agriculture and human values*, **28(1)**, 109-121.

Tanaka, Y. & Sato, Y. (2005). Farmers managed irrigation districts in Japan: Assessing how fairness may contribute to sustainability. *Agricultural Water Management*, **77(1-3)**, 196-209.

Tang, S. Y. & Ostrom, E. (1993). The governance and managment of irrigation systems. An institutional perspective. *Irrigation Management Network. Overseas Development Institute.* UK: ODI.

Tesfay, G., Gebresamuel, G., Gebretsadik, A., Gebrelibanos, A., Gebremeskel, Y. & Hagos, T. (2014a). Participatory Rural Appraisal Report: Endamehoni Woreda, Tigray. *Cascape Working Paper 2.6.3.* University of Wageningen.

Tesfay, G., Gebresamuel, G., Gebretsadik, A., Gebrelibanos, A., Gebremeskel, Y. & Hagos, T. (2014b). Participatory Rural Appraisal Report: Raya Azebo Woreda, Tigray. *Cascape Working Paper 2.6.5.* Netherlands: University of Wageningen.

Tewolde, T. (April 2019). *RE:* Assistant Professor, Hydrogeology. Mekele University, Ethiopia. *Personal communication.*

Theis, S., Lefore, N., Meinzen-Dick, R. & Bryan, E. (2018). What happens after technology adoption? Gendered aspects of small-scale irrigation technologies in Ethiopia, Ghana, and Tanzania. *Agriculture and Human Values*, 1-14.

Thompson, J. A. (2016). Intersectionality and water: How social relations intersect with ecological difference *Gender, Place & Culture*, **23(9)**, 1286-1301.

Torres, E. & Zambrano, J. (2000). Hidrogeología de la provincia de Mendoza. *In:* Junín (ed.). Mendoza, Argentina: Sistema Geoestadístico Provincial.

Tortajada, C. & Biswas, A. K. (2011). Improving Water Policy and Governance. Hoboken: Taylor and Francis.

Udas, P. (2014). *Gendered participation in water management in Nepal: Discourses, policies and practices in the irrigation and drinking water sectors.* PhD thesis, Wageningen University.

Udas, P. & Zwarteveen, M. (2010). Can water professionals meet gender goals? A case study of the Department of Irrigation in Nepal. *Gender and Development*, **18(1)**, 87-97.

UN-Water. (2019). *World Water Day 2019 – Leaving no one behind*. URL: http://www.unwater.org/world-water-day-2018-2/ [08 March 2019].

UN-Women (2018). Turning promises into action: Gender equality in the 2030 Agenda for Sustainable Development. UN Women.

UNDP. (2016). *Human Development Reports 2016*. URL: http://www.hdr.undp.org/en/2016-report [08 June 2018].

UNDP. (2018). *Human Development Reports 2018*. URL: http://hdr.undp.org/sites/default/files/2018_human_development_statistical_update.pdf [10 February 2019].

UNDP. (2019). *Sustainable Development Goals*. URL: https://www.undp.org/content/undp/en/home/sustainable-development-goals.html [31 May 2019].

UNESCO WWAP. (2019). *World Water Assessment Programme (UNESCO WWAP)*. URL: http://www.unesco.org/new/en/natural-sciences/environment/water/wwap/water-and-gender/ [31 May 2019].

Upadhyay, B. (2003). Water, poverty and gender: Review of evidences from Nepal, India and South Africa. *Water Policy,* **5(5-6)**, 503-511.

Upadhyay, B., Samad, M. & Giordano, M. (2005). Livelihoods and gender roles in drip-irrigation technology: A case of Nepal. Colombo, Sri Lanka: International Water Management Institute.

Uphoff, N. T. (1986). *Improving international irrigation management with farmer participation: Getting the process right.* Westview Press Boulder, CO.

van Buuren, A., van Meerkerk, I. & Tortajada, C. (2019). Understanding emergent participation practices in water governance. *International Journal of Water Resources Development* **35(3)**, 367-382.

Van Den Berg, M. & Ruben, R. (2006). Small-scale irrigation and income distribution in Ethiopia. *Journal of Development Studies,* **42(5)**, 868-880.

van Houweling, E., Hall, R., Diop, A. S., Davis, J. & Seiss, M. (2012). The role of productive water use in women's livelihoods: Evidence from rural Senegal. *Water Alternatives,* **5(3)**, 658-677.

Van Koppen, B. (1998). Water rights, gender, and poverty alleviation. Inclusion and exclusion of women and men smallholders in public irrigation infrastructure development. *Agriculture and Human Values,* **15(4)**, 361-374.

Van Koppen, B. (2002). A gender performance indicator for irrigation: Concepts, tools and applications. Colombo: Sri Lanka: International Water Management Institute.

Van Koppen, B. (2017). Rural women's rights to water for health, food, and income. Expert paper EGM/RWG/EP 7, 20-22 September. Rome: UN Women, IFAD, FAO, WFP Expert Group Meeting.

Van Koppen, B., Hellum, A., Mehta, L., Derman, B. & Schreiner, B. (2017). Rights-based freshwater governance for the twenty-first century: Beyond an exclusionary focus on domestic water uses. *In:* Karar, E. (ed.) *Freshwater Governance for the 21st Century,* pp. 129-143. New York, USA. Springer International Publishing.

Van Koppen, B. & Hussain, I. (2007). Gender and irrigation: Overview of issues and options. *Irrigation and Drainage: The journal of the International Commission on Irrigation and Drainage,* **56(2-3)**, 289-298.

van Koppen, B., van Etten, J., Bajracharya, P. & Tuladhar, A. (2001). Women irrigators and leaders in the West Gandak Scheme. Nepal.

Vaz-Jones, L. (2018). Struggles over land, livelihood, and future possibilities: Reframing displacement through feminist political ecology. *Signs: Journal of Women in Culture and Society,* **43(3)**, 711-735.

Vera Delgado, J. (2005). Irrigation management, the participatory approach, and equity in Andean community. *In:* Bennett, V., Dávila-Poblete, S. & Rico, N. (eds.) *Opposing currents: The politics of water and gender in Latin America,* pp. 109-122. Pittsburgh, USA: University of Pittsburgh Press.

Vera Delgado, J. R. & Zwarteveen, M. (2017). Queering Engineers? Using History to Re-think the Associations Between Masculinity and Irrigation Engineering in Peru. *Engineering Studies,* **9(2)**, 140-160.

Vermillion, D. L. (1999). Property rights and collective action in the devolution of irrigation system management. Workshop on Collective Action, Property Rights, and Devolution of Natural Resources, June, 1999. pp.21-24.

Visvanathan, N., Duggan, L., Wiegersma, N. & Nisonoff, L. (2011). *Women, Gender and Development Reader, The.* London: Zed Books.

Wallace, T. & Coles, A. (2005). *Gender, water and development.* Oxford: Berg.

White, S. C. (1996). Depoliticising development: the uses and abuses of participation. *Development in practice*, **6(1)**, 6-15.

WHO. (2008). *Khat chewing in Yemen: Turning over a new leaf*. URL: https://www.who.int/bulletin/volumes/86/10/08-011008/en/ [25 May 2019].

Woodhouse, P., Veldwisch, G. J., Venot, J.-P., Brockington, D., Komakech, H. & Manjichi, Â. (2017). African farmer-led irrigation development: re-framing agricultural policy and investment? *The Journal of Peasant Studies*, **44(1)**, 213-233.

WWDSE (2015). Environmental Impact Assessment - Draft Final Report. *In:* Ministry of Water Resources (ed.) *Raya Pressurised Irrigation Project - Feasibility Study, Design Works and Tender Document Preparation.* Addis Ababa: Water Works Design and Supervision Enterprise.

WWDSE&CECE (2014a). Raya Valley irrigation project - Feasibility study. Agricultural and marketing planning. Ministry of Water Resources. Addis Ababa, Ethiopia.

WWDSE&CECE (2014b). Raya Valley Irrigation Project - Feasibility study. Organisational Management Assessment. Ministry of Water Resources. Addis Ababa, Ethiopia.

Yami, M. (2013). Sustaining participation in irrigation systems of Ethiopia: What have we learned about water user associations? *Water Policy*, **15(6)**, 961-984.

Yami, M. (2016). Irrigation projects in Ethiopia: what can be done to enhance effectiveness under 'challenging contexts'? *International Journal of Sustainable Development & World Ecology*, **23(2)**, 132-142.

Yazew, E., Gebru, T., G/Egziabher, T.-a., Mezgebu, A., Fessehaye, D., Habtu, S., Haile, A., Steenberger, F. v. & Wester, F. (2010). Spate irrigation system in Raya Valley, Ethiopia. Spate Irrigation Network. Overview Paper Spate Irrigation. Addis Ababa, Ethiopia.

Yin, R. (2003). *Case study research. Design and Methods.* Third Edition ed. California: Sage.

Yohannes, D. F., Ritsema, C., Solomon, H., Froebrich, J. & van Dam, J. (2017). Irrigation water management: Farmers' practices, perceptions and adaptations at Gumselassa irrigation scheme, North Ethiopia. *Agricultural Water Management*, **191**, 16-28.

Zwarteveen, M. (1997). Water: From basic need to commodity: A discussion on gender and water rights in the context of irrigation. *World Development*, **25(8)**, 1335-1349.

Zwarteveen, M. (2008). Men, masculinities and water powers in irrigation. *Water Alternatives*, **1(1)**, 111-130.

Zwarteveen, M. (2011). Questioning Masculinities in Water *Economic and Political Weekly*, **XLVI(18)**.

Zwarteveen, M. & Bennett, V. (2005). The connection between gender and water managment. *In:* Bennett, V., Dávila-Poblete, S. & Rico, N. (eds.) *Opposing currents: The politics of water and gender in Latin America*, pp.13-29. Pittsburgh, USA: University of Pittsburgh Press.

Zwarteveen, M. & Meinzen-Dick, R. (2001). Gender and property rights in the commons: Examples of water rights in South Asia. *Agriculture and human values*, **18(1)**, 11.

Zwarteveen, M. & Neupane, N. (1995). Gender aspects of irrigation management: the Chhattis Mauja irrigation system in Nepal.

Zwarteveen, M., Udas, P. B. & Delgado, J. V. (2010). Gendered dynamics of participation in water management in Nepal and Peru: Revisiting the linkages between membership and power. *In:* Berry, K. A. a. M., E., (ed.) *Social Participation in Water Governance and Management: Critical and Global Perspectives*, pp.69-92.. London, UK: Earthscan.

Appendices

A. List of interviews and participants by code

Appendix 1 – List of in-depth interviews - Mendoza

ID	Date	Gender of participant	River Basin	Position/organisation
A_M-ID-01	18/04/2016	M	Central Water Agency	Deputy Coordinator DGI
A_M-ID-02	25/04/2016	M	Central Water Agency	Director of Finance - DGI
A_Ti-ID-03	19/04/2016	M	Lower Tunuyán River	Regional Agricultural Office - Director
A_M-ID-04	18/04/2016	F	Central Water Agency	Technical officer - DGI
A_3aM-ID-05	28/07/2016	M	Mendoza River	Manager second level WUAs
A_3aM-ID-06	01/08/2016	M	Mendoza River	WUA leader
A_3aM-ID-07	08/08/2016	M	Mendoza River	WUA leader
A_3aM-ID-08	13/08/2016	M	Mendoza River	WUA leader
A_3aM-ID-09	18/08/2016	M	Mendoza River	WUA leader
A_M-ID-10	04/08/2016	M	Central Water Agency	Planning officer
A_M-ID-11	05/08/2016	F	Central Water Agency	Planning officer
A_M-ID-12	08/08/2016	M	Central Water Agency	Engineering officer - Director Engineering Department
A_M-ID-13	09/08/2016	M	Central Water Agency	Coordinator WUAs - DGI
A_M-ID-14	19/08/2016	M	Central Water Agency	Technical Director DGI
A_M-ID-15	19/08/2016	M	Central Water Agency	Auditing Department DGI - Director
A_M-ID-16	29/08/2016	M	Mendoza River	DGI Delegate
A_At-ID-17	02/09/2016	M	Atuel River	Atuel River Council
A_Ti-ID-18	23/09/2016	M	Lower Tunuyán River	WUA leader
A_Ti-ID-19	23/09/2016	M	Lower Tunuyán River	Manager second level WUAs
A_Ti-ID-20	29/09/2016	M	Lower Tunuyán River	Technical officer
A_Ti-ID-21	14/10/2016	M	Lower Tunuyán River	DGI Delegate
A_At-ID-22	17/10/2016	M	Atuel River	DGI Delegate
A_At-ID-23	17/10/2016	M	Atuel River	WUA leader
A_At-ID-24	18/10/2016	M	Atuel River	WUA leader
A_At-ID-25	18/10/2016	M	Atuel River	WUA leader
A_At-ID-26	18/10/2016	M	Atuel River	Member Water Committee, WUA
A_At-ID-27	18/10/2016	F	Atuel River	Accountant for WUAs
A_At-ID-28	19/10/2016	M	Atuel River	Farmer, former WUA leader
A_At-ID-29	19/10/2016	M	Atuel River	WUA leader
A_Ts-ID-30	24/10/2016	M	Lower Tunuyán River	WUA leader
A_Ts-ID-31	24/10/2016	M	Lower Tunuyán River	WUA leader

A_Ts-ID-32	24/10/2016	M	Lower Tunuyán River	WUA leader
A_Ts-ID-33	25/10/2016	M	Lower Tunuyán River	WUA leader
A_Ts-ID-34	25/10/2016	M	Lower Tunuyán River	WUA leader
A_Ti-ID-35	26/10/2016	M	Lower Tunuyán River	Manager second level WUAs
A_Ts-ID-36	27/10/2016	F	Lower Tunuyán River	Farmer, former WUA leader
A_Di-ID-37	01/11/2016	M	Diamante River	DGI Delegate
A_Ma-ID-38	02/11/2016	M	Malargüe Irrigation Zone	Malargüe Irrigation Zone - Delegate DGI
A_3aM-ID-39	14/04/2016	F	Mendoza River	WUA leader
A_M-ID-40	11/10/2016	M	Central Water Agency	Engineering officer

Appendix 2 – List of FGD - Mendoza

ID	Date	Gender of participant	River Basin	Position/organisation
A_3aM-G-01	30/08/2016	M	Mendoza River	Male farmers
A_Ti-G-2	15/09/2016	M	Lower Tunuyán River	2nd grade WUA - WUAs leaders
A_Ti-G-03	14/10/2016	F	Lower Tunuyán River	Women farmers, mixed married and household heads
A_Ts-G-05	25/10/2016	F	Upper Tunuyán River	Women farmers, mixed married and household heads
A_Ti-G-08	23/05/2017	F	Lower Tunuyán River	Women farmers
A_Ti-G-09	31/05/2017	F	Lower Tunuyán River	Women farmers
A_Ti-G-10	01/06/2017	F, M	Lower Tunuyan River	Women and male farmers - couples
A_M-G-01	17/05/2017	F	Central Water Agency	Women agronomists

Appendix 3 – List of open interviews - Mendoza

ID	Date	Gender of participant	River Basin	Position/organisation
A_3aM-Op-09	23/08/2016	M	Mendoza River	Technical Director - DGI
A_M-Op-03	19/04/2016	M	Central Water Agency	Engineering officer - DGI
A_M-Op-04	26/04/2016	M	Central Water Agency	DGI General Director
A_M-Op-05	26/04/2016	M	Central Water Agency	Engineering officer - DGI
A_M-Op-06	28/04/2016	M	Central Water Agency	Engineering officer - DGI
A_M-Op-07	12/05/2016	M	Central Water Agency	Legal Department DGI - Director
A_M-Op-08	16/05/2016	M	Central Water Agency	Various DGI staff
A_M-Op-09	29/04/2016	M	Central Water Agency	Engineering officer - DGI
A_M-Op-10	28/04/2016	M	Central Water Agency	Officer Planning Department DGI
A_M-Op-11	10/05/2016	M	Central Water Agency	WUA manager
A_Ti-Op-01	12/04/2016	M	Lower Tunuyan River	2nd grade WUA manager
A_Ti-Op-02	12/04/2016	M	Lower Tunuyan River	Technical officer
A_Ti-Op-10	23/09/2016	F	Lower Tunuyán River	Technical Director - DGI
A_Ts-Op-01	10/11/2016	F	Upper Tunuyan River	Women farmers and women extension officers

Appendix 4 – List of observations and participation in relevant events - Mendoza

ID	Date	River	Activity
A_Ti-O-01	22/04/2016	Lower Tunuyán River	DGI Provincial Water Conference
A_M-O-02	28/04/2016	General for the province	DGI conference: Minor O&M led by WUAs
A_M-O-03	04/05/2016	General for the province	DGI technical seminar: Water supply and demand
A_2aM-O-04	05/05/2016	Mendoza River	WUA's assembly - Cash flow revision
A_2aM-O-05	06/05/2016	Mendoza River	WUA's assembly - Cash flow revision
A_2aM-O-06	12/05/2016	Mendoza River	WUA's assembly - Cash flow revision
A_3aM-O-07	16/05/2016	Mendoza River	WUA's assembly - Cash flow revision
A_At-O-08	17/10/2016	Atuel River	WUA assembly - Budget agreement
A_At-O-09	18/10/2016	Atuel River	WUA assembly - Budget agreement
A_Ti-O-10	20/10/2016	Lower Tunuyán River	WUA assembly - Budget agreement
A_Ti-O-11	20/10/2016	Lower Tunuyán River	WUA assembly - Budget agreement
A_3aM-O-12	21/10/2016	Mendoza River	WUA assembly - Budget agreement
A_Ts-O-13	24/10/2016	Upper Tunuyán River	WUA assembly - Budget agreement
A_3aM-O-16	26/10/2016	Mendoza River	WUA assembly - Budget agreement
A_Ti-O-15	26/10/2016	Lower Tunuyán River	WUA assembly - Budget agreement
A_5aM-O-17	27/10/2016	Mendoza River	WUA assembly - Budget agreement
A_Ts-O-14	25/11/2016	Upper Tunuyán River	WUA assembly - Budget agreement
A_Ts-O-18	28/11/2016	Upper Tunuyán River	WUA assembly - Budget agreement

Appendix 5 – List of in-depth interviews - Tigray

ID	Date	Gender of participants	Municipality	Role
E_Em-ID-01	13/03/2018	F	Embahaste	Female farmer
E_Em-ID-02	15/03/2018	F	Embahaste	Abomay
E_Tb-ID-01	16/03/2018	F	Tsibet	Abomay
E_Tsi-ID-01	25/01/2016	M	Tsiga	Abomay
E_Tsi-ID-02	05/02/2016	M	Tsiga	Abomay
E_Tsi-ID-03	30/01/2016	M	Tsiga	Kebele Chairman
E_Wa-ID-01	26/01/16	M	Wargiba	Farmer/WUA's member
E_Wa-ID-02	27/01/2016	M	Wargiba	Agricultural officer
E_Wa-ID-03	06/02/2016	M	Wargiba	Abomay
E_Ka-ID-01	27/01/16	M	Kara	Head of Agriculture Office
E_Ka-ID-02	05/02/2016	F	Kara	Agricultural officer
E_Mk-ID-01	11/01/2016	M	Mekele	Planning Director - Water Bureau
E_Mk-ID-02	11/01/2016	F	Mekele	Gender expert - Water Bureau
E_Mk-ID-03	08/02/2016	M	Mekele	REST (NGO) Irrigation Expert
E_Mh-Op-01	25/01/2016	M	Mohoni	Raya Azebo *Woreda* Agriculture Office
E_Mh-ID-01	14/03/2018	M	Mohoni	Raya Azebo *Woreda* Agriculture Office's Head
E_May-ID-01	13/01/2016	M	Maychew	Water Supply office Maychew

Appendix 6 – List of FGD - Tigray

ID	Date	Gender of participants	N	Municipality	Position/organisation
E_Em-G-01	02/02/2016	Female	2	Embahaste	WUA's female members
E_Em-G-02	13/03/2018	Female	4	Embahaste	WUA's female members, heads of household
E_Em-G-03	15/03/2018	Female	3	Embahaste	WUA's female members, married (non-heads of household)
E_Tb-G-01	03/02/2016	Male	2	Tsbet	WUA leaders
E_Tb-G-02	03/02/2016	Male	2	Tsbet	WUA leaders
E_Tb-G-03	13/03/2018	Female	7	Tsbet	WUA's female members, heads of household
E_Wa-G-01	30/01/2016	Male	5	Wargba	WUAs' members, WC members
E_Wa-G-02	16/03/2018	Female	8	Wargba	WUAs' female members, mixed married and heads of household

E_Ka-G-01	29/01/16	Male	6	Kara Adishebo	WUAs' members, WC members
E_Ka-G-02	05/02/2016	Female	3	Kara Adishebo	WUA's female members, heads of household
E_Ka-G-03	14/03/2018	Female	3	Kara Adishebo	WUA's female members, heads of household
E_Ka-G-04	16/03/2018	Female	5	Kara Adishebo	WUA's female members, married (non-heads of household)

Appendix 7 – List of open interviews -Tigray

ID	Date	Gender of participant	Municipality	Position/organisation
E_Em-Op-01	02/02/2016	F	Embahaste	Irrigation expert
E_Em-Op-02	13/03/2018	F	Embahaste	Irrigation expert
E_Tb-Op-01	04/02/2016	F	Tsbet	Irrigation expert
E_Tb-Op-02	04/02/2016	F	Tsbet	Female farmer
E_Tb-Op-03	04/02/2016	M	Tsbet	Female farmer
E_Tb-Op-04	15/03/2018	F	Tsibet	Irrigation expert
E_Tb-Op-05	15/03/2018	F	Tsibet	Female farmer
E_Wa-Op-01	26/01/16	M	Wargiba	Various farmers
E_Wa-Op-02	26/01/16	F	Wargiba	Female labourer
E_Wa-Op-03	27/01/16	F	Wargiba	Female labourer
E_Wa-Op-04	02/06/2016	F	Wargiba	Female farmer
E_Wa-Op-05	26/01/16	F	Wargiba	Female farmer
E_Ka-Op-01	02/05/2016	M	Kara Adishebo	WUA's member
E_Ka-Op-02	14/03/2018	F	Kara Adishebo	Female farmer

B. Research tools

Appendix 8 – Key informant interview example questions for community characterisation

This questionnaire presents examples of guiding questions to key informants for community characterisation.

Can you please provide some information about yourself?

- Position in the office
- Background, area of expertise
- How long have you been working in this office/position?
- Contact details

SUPPORT TO RURAL COMMUNITIES

1. Could you please describe the services of this office?

1.1. Geographical coverage

[Government structure: description and presence of the organization at the regional and local levels]. Type of services/activities: __________________

1.2. Target population
1.3. Resources to provide those services: e.g. infrastructure (offices); personnel (n. of staff, in particular in technical positions; extension officers; transportation (n. of cars to go to the field)
1.4. How many employees does the office/department have?
1.5. How many women work here?
1.6. Can you describe their positions? And their level of instruction?
1.7. What are the obstacles in hiring female staff (especially extension agents)?

2. Which are the main needs that you identify when doing your work with your target beneficiaries/ communities?

[We need to identify: a) needs of the institution; b) needs of their target population, c) needs institutions are unable to meet]

3. Which are the main constrains/obstacles that you/the office face in order to provide your services to your target communities?

[We want to identify their capacity to provide services]

4. Does your office/programme have specific policies, programmes and/or projects that include gender issues?

4.1. If yes, could you describe those policies, areas implemented and process?
4.2. How would you describe the impact of those policies/programs?

5. Are there any organizations in the region that focus on women's issues particularly for irrigation and related topics?

LIVELIHOOD PROFILING WITHING LIVELIHOOD ZONES – community level

6. Could you identify the livelihood groups living in the region (district/subdistrict)?
7. Could you identify well-being classification of different groups? (E.g. rich, medium, poor, destitute, etc.)
8. Could you describe each group? (land size, n. of animals by species, hired labour, access to market)
9. Could you describe the condition of farmers in this area? What do you think are their problems? (e.g. environmental, productive, water, market, socio-economic, etc.)

9.1. Could you describe the problems of men?

9.2. And the problems of women?

COMMUNITY RESOURCES

Infrastructure availability in the district/subdistrict, e.g. education, health and agricultural extension facilities.

MARKET ACCESS

13. Does the village have access to road? Yes ☐ No ☐

14. What type of road connects the village with the local market? _______________

References

(a) *1= dirt; 2=gravel; 3=asphalt; 4=no road*

15. What means do rural communities most frequently use to transport your products to market? _____________

References

(a) *1=truck; 2=tractor; 3=car; 4=motorcycle; 5=trailer; 6=donkey cart; 7=donkey; 8=camel; 9=by foot; 10=other means (specify here)* . . . .

Appendix 9 – Key informant interview example questions – WUA leaders

Part 1: Water source and irrigation systems

1. Can you please tell us about the source of water do members of the association use for irrigation? e.g., rainwater; springs; river; canals; community borehole; deep well (groundwater); own borehole; other sources.

   1.1. Has the irrigation water source changed in the last years? No☐ Increased☐ Decreased ☐

   1.2. Which are the major reasons for the change? (use additional paper)

2. What irrigation systems are used by the association's members? (i.e. spate irrigation; furrow; pressurised, other? Which type is the most frequent?

2.1. How did farmers learn about the operation of these irrigation systems?

Part 2: WUAs organizational functioning

1. Could you please tell us the history of the water committee? (*Guiding comments: when and how was it created; who participated originally; why was it created?*)
2. Which are the requisites to become a member of this WUA?
3. Which could be reasons for losing membership?
4. Which is the legal figure of this WUA?

   4.1. Is it registered already? Yes ☐ → when was it registered? _________________
   No ☐→ if not register, why not?

5. Is it a multipurpose organisation? Yes ☐ No ☐ → If not, is it a cooperative? Yes ☐ No ☐
   If yes, which are the main activities of the association?
6. What are **the main responsibilities** of the WUA?

   Guiding questions:

   6.1. Does the WUA regulate use and distribution of the water?
   Yes ☐ → How does it work?
   No ☐→ If not, who does it?

   6.2. Does the WUA have authority to make rules and regulations?
   Yes ☐ → Could you please describe?
   No ☐→ If not, who has this authority?

   6.3. Does the WUA have authority to apply sanctions according to water policy?
   Yes ☐ → Could you please describe?
   No ☐→ If not, who has this authority?

   6.4. Does the WUA have authority to set water/maintenance fees?

   Yes ☐ → Could you please describe?

   No ☐→ If not, who has this authority?

   6.5. Does the WUA resolve disputes, if any, between members in its area of operation?

   Yes ☐ → Could you please describe?

   No ☐→ If not, who does it?

   6.6. Does the WUA resolve dispute and conflicts with no members of the command area?

   Yes ☐ → Could you please describe?

   No ☐→ If not, who does it?

   6.7. Any other responsibility?

6.8. Is there written documentation of the WUA rules and regulations that we could access?

7. What are the **main activities** of the WUA?
   Guiding questions:
   7.1. Does the WUA prepare its own budged? Could you please describe?
   7.2. Does the WUA prepare its own irrigation scheme (plans of distributing water, schedules, other)? Could you please describe?
   7.3. Does the WUA prepare a plan for the maintenance of the irrigation system in its command area?
   7.4. Does the WUA carry out the maintenance work?
   7.5. Does the WUA collect the fees for operation and maintenance?
   7.6. What other activities does it perform?

8. What are the **rights** of the WUA's members?
   Guiding questions
   8.1. Right to vote decisions: Could you please describe?
   8.2. Amount and timing of water access: How are they defined?
   8.3. Benefits (e.g. agricultural inputs, participation in trainings, other): Could you please describe?

9. Could you describe the budget composition of the association? (e.g. user's fees; government support; other)
10. Which are the **main obligations** of the WUA's members?
11. Can you describe the **main positions and responsibilities** existing in the WUA (or water committee)?

Position	Main responsibilities	Duration of the mandate	It is a paid position?
1.			Yes ☐ No ☐
2.			Yes ☐ No ☐
3.			Yes ☐ No ☐

12. How does the WUA select its authorities? Please describe the selection process.
    Guiding questions:
    12.1. Who can be selected?
    12.2. Which are the requisites to become a committee's authority?
    12.3. How are the authorities elected?
    12.4. Which is the duration of the mandate?

13. Do the water committee's members have additional benefits (e.g. access to higher amount of water; reduction in fees; other)? No ☐ Yes☐ If yes, are those benefits?
14. Is there a quota for female participation? No ☐ Yes☐ If yes, which is this quota?
15. Does having a female participation quota have improved women's participation? Could you please explain? (consider participation of women with and without quota)
16. Could you please discuss about how women participate in the WUA? (*guiding questions: level of participation; type of activities; frequency of participation; holding office positions; decision making; speaking up in public*)

17. Now we will ask some questions regarding the water committee members

Position	Gender	Main responsibilities
1.		
2.		
3.		

18. We will now ask a few questions regarding the type of meetings that the association organises

	Type of meetings (by purpose)	Frequency	Purpose	Who participates? (a)
1				
2				
3				

References

(a) 1=Water committee members; 2=all WUA members; 3=other (specify)

19. Now we would need some information about where meetings take place:

	Type of meetings (by purpose)	Response	Comments
a	Location of meetings	1. Own office? ☐ 2. Rented office? ☐ 3. Borrowed office? ☐ 4. House of a committee member? ☐ 5.Other__________________	
b	Accessibility to location of meetings	1. Bus ☐ 2. Taxi ☐ 3. Bajaj (Tigray) ☐ 4. Walking ☐ 5. Own vehicle ☐ 6. Other__________________	
c	Usual time of meetings		

20. Do you keep written records of meetings? No ☐ Yes ☐
    If yes, could we please give a look to attendance records?
21. Does the WUA receive any support from the government? No ☐ Yes ☐
    If yes, could you please describe?
22. Does the WUA receive any support from an NGO or a cooperation project(s)? No ☐ Yes ☐
    If yes, could you please describe?

Appendix 10 – FGD example questions - WUA leaders

Part 1: WUAs organizational functioning

1. What do you think are the main challenges for irrigation in this area?
2. Having this water committee has improved any of those challenges listed?
3. What are the advantages and problems of having this water committee?
4. What are the main improvements that you would introduce to the functioning of the water committee?

Part 2: Gender participation in the WUA

5. Is there a quota for female participation? No ☐ Yes☐
   If yes, which is this quota? Which is the actual number of women in this water committee?
6. Does having a female participation quota have improved women's participation? Could you please explain? (consider participation of women with and without quota)
7. What do you think are positive aspects of having a female participation quota?
8. What do you think are problematic aspects of having a female participation quota?
9. Could you please discuss how women participate in the WUA? (*Guiding questions: level of participation; type of activities; frequency of participation; holding office positions; decision making; speaking up in public*)
10. What are the types of work men most frequently perform in the WUA?
11. What are the types of work women most frequently perform in the WUA?
12. Have you ever received training on how to organise an association? No ☐ Yes☐
    If yes, could you describe the most important aspects you should consider for the good functioning of the organisation? (*Identify what the participants consider as 'good' organisation*)
13. Have you received any other training in the last 3 years? No ☐ Yes☐
    If yes, could you please name them?

Appendix 11 – FGD example questions – female farmers

Part 1: Water access and WUAs organizational functioning

1. Do you have problems to access irrigation water? Have you ever had problems to access water?
2. Do you access same amount of water than male farmers?
3. Do you irrigate your land? What time of the day do you get water? How often? Is this the same as men?
4. Are there traditions that prevent women from irrigating? If yes, which are those traditions?
5. What do you think are the main challenges for irrigation in this area?
6. How was irrigation for you before being part of the WUA?
7. What are the advantages and problems of having this WUA?
8. What are the main improvements that you would introduce to the functioning of the water committee?
9. Is the amount of fees for the WUA difficult to pay for you?

Part 2: Gender participation in the WUA

10. Is there a quota for female participation? No ☐ Yes☐
    If yes, which is this quota? Which is the actual number of women in this water committee?
11. Does having a female participation quota have improved women's participation? Could you please explain? (consider participation of women with and without quota)
12. What do you think are positive aspects of having a female participation quota?
13. What do you think are problematic aspects of having a female participation quota?
14. Could you please discuss <u>how</u> women participate in the WUA?
    a. How often do you attend WUAs' meetings?
    b. Do women speak in the meetings? Which women?
    c. Do wives of male members participate of the meetings? Do they speak up in the meetings?
    d. Do you vote in the meetings?
    e. Are meetings useful?
    f. Would you like to have a position in the water committee?
15. Do you cultivate your own plot?
16. What crops do women usually grow?
17. What crops do men usually grow?
18. Who decides in your homes what to plant?
19. Have you received any training in the last 3 years? No ☐ Yes☐
    If yes, could you please name them?
20. How do you learn about irrigation/farming? (e.g. sprinkle or drip irrigation)
21. How do you learn about new training activities?
22. Women in this area without land, how they get incomes?
23. Do you have mobile phone?

Appendix 12 – Survey to farmers: Irrigation in Raya Valley, Tigray, Ethiopia

Good morning/afternoon. My name is Laura Imburgia. I am a student at University of Reading, in UK. I am conducting this survey as part of my doctorate studies. I would like to learn about the agricultural activities of farmers, men and women, of Raya Valley; their irrigation practices and how they are organised to work with other farmers. This study has no relationship with any government or NGO programme of Ethiopia or elsewhere. The information that you provide will remain confidential, your name will not be used, and our conversation will be used for the sole purpose of my research. We can stop this survey at any moment and if you are not comfortable with any part of the conversation, please let me know. Also if you have any question please do not hesitate to ask me at any moment. Many thanks in advance.

IDENTIFICATION DATA

- **Interviewee basic information:**

Interviewee name	Gender	Reference code
	☐ (1) Male (2) ☐ Female	

Place of birth (Region, zone)	Mother language

- **Location:**

Community code/name	Kebele	Woreda	Zone

- **Communication:**

Accessibility	Distance (km)	Type of road
Distance to all weather road		

Type of road: 1=gravel; 2=consolidated; 3=no road

- **Interviewer basic information:**

Interviewer Name	Transcription made by	Interview Date

- **Household description**

Household type	Position of the interviewee in the household

1=Male headed; 2= Female headed; 3= Male headed but husband away

1=head; 2=spouse; 3=parent; 4= son/daughter; 5=son/ daughter-in-law; 6=brother/sister; 7=Other (specify)

Part 1: Household livelihood structure

Production systems

1. How long have you lived here? ________ months/years
2. How long have you farmed this land? ________ months/years
3. How much land do you use? a) Rain-fed land for crop production ________ ha
   b) Land with irrigation system for crop production ________ ha
   c) Land for livestock _______ ha
4. How much of the land you use is: owned _____ ha; rented _______ ha; communal ________ha

5. Do you have a land certificate for your own land? Yes ☐ No ☐

(a) If **yes**, whose name is on the certificate? ___________

References *1=yours; 2=spouse; 3=father; 4=mother; 5=brother; 6=sister; 7=grandfather; 8=grandmother; 9=Other (specify here) . . . .*

How long have you had the land certificate? ________ (months, years)

(b) If **no**, which is the legal status of the land? __________

References *1=I have requested the certificate; 2= It is a communal land; 3=I don't know the owner of the land; 4=Other (specify here) . . . .*

6. **Agricultural production:** Now we would like to learn about your crop productions during the last year *(Complete with the appropriate information. See references below the table):*

#	What crops do you grow?	*Mark with X*	6.1. Production			
			Area planted (ha)[264]	Yields (please note units)	Amount used in the HH (a)	Amount send to market (a)
1						
2						
3						

References

a) 1=most or all; 2=some amount; 3=nothing

ϕ The person doesn't know

6.2. To what extent did your production changed within the since you got your land? (*Mark with X)*

#	What crops do you grow?	*Stable*	*Increased*	*Decreased*
1				
2				

6.3. Where do you get seeds/planting materials from? (*Mark with an X)*

#	Crop	*Sorghum*	*Maize*	*Teff*	*Wheat*	*Onions*	*Fodder*	*Fruit trees*	*Others (specify)*
1	Own production								
2	Friends/relatives								
3	Market								
4	Government								
5	Others								

[264] When appropriate, local units should be used.

6.4. Where do you normally sell your products? (*Mark with an X)*

#	Crop	*Sorghum*	*Maize*	*Teff*	*Wheat*	*Onions*	*Fodder*	*Fruit trees*	*Others (specify)*
1	On site								
2	Village market								
3	Woreda Market								
4	Other market (specify)								

7. Livestock production: Now we would like to learn about your livestock during the last year (*mark complete with the number of animals*). If no livestock owned, skip to question **8**

	Category	Cattle	Sheep	Goats	Donkey	Camels	Poultry
	Total						
1	Young stock						
2	Adult female						
3	Adult male						
4	Animals for draft (oxen)						

7.1. To what extent did your number of animals change within the last 10 years? (Mark with an X)

	Category	Cattle	Sheep	Goats	Donkey	Camels	Poultry
1	Stable						
2	Increased						
3	Decreased						

8. Where do you get your **income** from *(Mark with X)*:

Earned by	1. Crops	2. Livestock	3. Employment/ Salary/wage labour	4. Remittances	5. Cash for work	6. Charcoal/ Firewood	7. Own shop	8. Petty trade	9. Other
Men									
Women									
Both									

8.1. From question number 8, from which source do you get your highest income? (Write the source of income according to question 8) ______________________________

9. Who decides primarily (most of the time) the following:

	Category	Who decides (a)
1	Who decides most of the times what crops to plant? (e.g. teff, sorghum, vegetables)	
2	Who decides most of the times about irrigation?	
3	Who decides most of the times about buying or selling livestock?	

References

(a) *1=yourself; 2=spouse; 3= both; 4=Other (specify here). . . . .*

AGRICULTURAL EQUIPMENT, TOOLS AND VEHICLES

10. Could you describe the agricultural equipment and vehicles that you use? (*complete with the appropriate information*)

Equipment/vehicles	Units	Property (a)
Basic farming tools		
Plough/animal draft		
Tractor		
Bajaj		
Car		
Truck		
Other (specify)		

References

(a) 1=own; 2=rent; 3=borrow; 4=not needed; 5=don't have

ϕ *The person doesn't know*

FINANCIAL CAPITAL

11. Do you or a member of your family have a bank account? Yes ☐ No ☐ I don't know ☐

If yes, whose name is on it? ______________________

References

(a) 1=yours; 2=your spouse; 3=both

12. Have you or a member of your family taken loans in the last 5 years?

Yes ☐ No ☐ I don't know ☐

If yes, could you let us know how have you used the loan? (a) _____________

References

(a) 1=agriculture production; 2=livestock; 3=house; 4=family use (medical use; birth; marriage; funeral); 5=education of children; 6=other (specify). . . . .

12.1. If the answer is yes from question 12, from whom do you get the credit?

References

(a) 1=DEDEBIT; 2=banks; 3=private lenders; 4=cooperatives; 5=family or friends; 6=other……

Part 2: Water resource management

WATER

Domestic water

13. Do you have a drinking water source on your land or compound? Yes ☐ No ☐

(a) If yes, which is the source of the water? *(mark with an X)*			(b) If no, where do you bring drinking water from? *(mark with an X)*			Walking distance (time)		
						Men	Women	Children
	Dry season	*Rainy season*		*Dry season*	*Rainy season*			
1. Piped supply			1. Community well					
2. River			2. River					
3. Canal			3. Canal					
4. Spring			4. Spring					
5. Deep well			5. Deep well (borehole)					
6. Hand pump			6. Distributed by the kebele					
7. Harvested (rain)			7. Harvested (rain)					
8. Other (specify)			8. Other (specify)					

13.1. Has the drinking water source changed within the last 10 years? No☐ Increased☐ Decreased ☐
13.2. Which are the major reasons for the change?
13.3. How much do you pay for drinking water?
____
14. Do you use this water for other uses?
No ☐ → *Skip the rest of the question.*
Yes ☐ → If your answer is **yes**, which are those uses?
____
(*It can be more than one answer*)
References *1=irrigating crops; 2=irrigating home garden (kitchen garden); 3=for the livestock 4=hygiene; 5= washing clothes; 6= cleaning; 7=Other (specify here) . . . .*

Irrigation water
15. Can you tell us what source of water do you use for your crops during different times of the year? *(mark with an X)*

	Type of Irrigation Source	All year round	Long rain (*Kiremt*) Jun-Sept	Long dry season Oct - Jan	Short rains (*Belg*) Feb - Mar	Short dry season Apr - May	Never	Don't know
1	Rainwater							
2	Springs							
3	River/ Canal (a)							
5	Community borehole (b)							
6	Own borehole (b)							
7	Other Source (specify)							

(a) Canal[265]: Please specify type of canal → main canal ☐ lateral canal ☐ Tertiary canal ☐
(b) Community borehole:
1. Is your borehole functional? Yes ☐ No ☐
2. Does it have an electric (1) or diesel (2) pump? ___________
3. How is the quality of the water? (a) ________

References *1=Good for irrigation; 2=No good for irrigation (polluted, saline)*
(a)
(c) Own borehole:
1. Is the borehole functional? Yes ☐ No ☐
2. Does it have an electric (1) or diesel (2) pump? ___________
3. Can you tell us:
   - Depth of the borehole ________ metres
   - Productivity (how much water do you extract) __________litres/hour
   - How long since construction? ________ years
   - Quality of the water? ________

References
(a) *1=Good for irrigation; 2=No good for irrigation (polluted, saline)*

___

[265] The level of knowledge of farmers regarding this information needs to be verified with local informants in Ethiopia.

16. Do you use this water for other purposes? Yes ☐ No ☐ → *Skip the rest of the question*

(a) If your answer is yes, which are those uses? (*It can be more than one answer*)

____

References *1=drinking and cooking;2=sanitation; 3=washing clothes; 4=for the home garden and animals; 5=Other (specify here) . . . .*

17. What system of irrigation do you use? (*mark with an X*)

	Irrigation system	All year round	Dry seasons
1	Rainfed -no irrigation infrastructure		
2	Traditional spate irrigation (local materials)		
3	Modernised spate irrigation (concrete or gravel partitions)		
4	Furrow irrigation		
5	Drip or sprinkle		
6	Other Source (specify)		

18. Do you have sufficient water for your farming during the year? __________

References *1= Yes, most of the time; 2=short periods of the year is not sufficient; 3=many periods of the year is not sufficient*

18.1. How was it in the past?[266] Is there any difference? More water____? Less water_____? Same______?

19. Do you have enough water for your animals during the year? __________

References *1= Yes, most of the time; 2=short periods of the year is not sufficient; 3=many periods of the year is not sufficient*

Rules and regulations

20. Do you have legal access to water? Yes ☐ No ☐

21. If **NO**, how do you access irrigation water? ____

22. Are there rules deciding the distribution of irrigation water between you and your neighbours?

(a) No ☐ → *Skip the rest of the question*

(b) Yes ☐ → If your answer is yes, please specify (*complete the table below*):

	Type of rules and regulations	(*Mark with X*)	7. How are those rules respected? (a)
1	Water committee's rules		
2	Government rules		
3	Informal (non written) rules		

References

(a) 1=good respect; 2=enough respect; 3=Low respect; 4=are not respected; 5=I don't know

NA The option is not applicable

ϕ *The person doesn't know*

Water user associations – Participation

23. Are you or somebody in your household a member of a water user association?

No ☐ → If not, why not? ____

Go to question 27

Yes ☐ → Who is the registered member of the water user association? (a)__________

References *(a) 1=yourself; 2=spouse; 3=Other (specify here) . . . .*

[266] Find out a past event of significance for the respondent to use as time reference.

ϕ *The person doesn't know*

24. If **you** are a registered member in the water users' association (WUA), do you have a formal position in the organization?

Yes ☐ → Which position? . . . .

No ☐ → Could you give more details why not? *(Use additional paper)*

25. When do you attend water committee meetings? ___________

References *1= always; 2= when I need water; 3= some times; 4=when other important issues are discussed; 5= never*

26. Now we would like to know some details about your water users' association (WUA):

	Details	Response	Comments
A	Which are the requisites to be a member? *(more than one answer is possible)*	1. Have a land certificate ☐ 2. Pay fees ☐ 3. Provide labour to maintain the system ☐ 4. Other______________________________	
B	Which of the requisites in the previous question (a) apply to your case?	1. ☐ 2. ☐ 3. ☐ 4. ☐	Other?
C	How would you rate the work of the water committee?	1. Very good ☐ 2. Acceptable ☐ 3. Not good ☐ 4. Not sure ☐	Why?
D	Do you contribute labour to the WUA?	Yes ☐ No ☐	If yes, which type of work? 1. Cleaning canals ☐ 2. Distributing water ☐ 3. Collecting fees ☐ 4. Other______________
E	What do you think about the amount of water that the water committee allocates to your plot/s?	1. Enough ☐ 2. Acceptable ☐ 3. Not enough ☐ 4. Not sure ☐	If not enough, when in the year? 1. During dry season ☐ 2. Most of the time ☐ 3. Only a short period ☐
F	What do you think about the timing when you receive the water? (Is water available when you need it most?)	1. Very good ☐ 2. Acceptable ☐ 3. Not good ☐ 4. Not sure ☐	
g	Do you pay fees to the WUA?	Yes ☐ No ☐	
h	If your answer to the previous question is yes, what do you think about the fees that you pay?	1. Fair ☐ 2. Too high ☐ 3. Too low ☐ 4. Not sure ☐	

Part 3: Gender roles, needs and preferences in agriculture and irrigation

Gender roles and responsibilities in crop production

27. Now we would like to learn about which member of your family carries out the following crop activities:

		Your family					Hired labour		
	Activity	You (a)	Spouse (a)	Girls (a)	Boys (a)	Children (a)	Men (a)	Women (a)	Children (a)
1	Land preparation								
2	Sowing								
3	Weeding								
4	Planting								
5	Irrigating								
6	Harvesting								
7	Preparation for market								
8	Processing								
9	Other (Specify)								

References *(a)* *1=every time; 2=sometimes; 3=never*

Gender roles and responsibilities in livestock management

28. Now we would like to learn about which member of your family carries out the following livestock work. If the household does not own livestock, skip to question **28**.

		Your family					Hired labour		
	Activity	You (a)	Spouse (a)	Girls (a)	Boys (a)	Children (a)	Men (a)	Women (a)	Children (a)
1	Feeding animals								
2	Animal health care								
3	Milking								
4	Moving herds to pasture areas								
5	Bringing animals to market								
6	Buying new animals								
7	Processing milk								
8	Feeding animals								

References *(a)* *1=every time; 2=sometimes; 3=never*

Gender roles and responsibilities in household work

29. Now we want to learn about how often the members of your family carry out the following work at home:

		Your family					Hired labour		
	Activity	You (a)	Spouse (a)	Girls (a)	Boys (a)	Children (a)	Men (a)	Women (a)	Children (a)
1	Cooking and cleaning								
2	Firewood collection								
3	Water collection								
4	House construction								
5	Take care of old people/small children								
6	Charcoal production								
7	Backyard garden								
8	Other (Specify)								

References *(a)* *1=every time; 2=sometimes; 3=never*

Part 4: Gender preferences and needs

30. What are the main problems of your irrigated land?
31. What are the main problems of your rainfed land?
32. What are your main problems of your livestock production?

Part 5: Household demography and education

33. Can you please give details about the members in your household, including yourself?

	Relationship to you	Age	Gender	Marital status	Education	Occupation
1	Yourself					
2						
3						

References

Gender *1=male; 2=female*
Marital status *1=married; 2=single; 3=widowed; 4=divorced*
Education *1=no education; 2=primary incomplete; 3= primary complete; 4=secondary; 5=post-secondary; 6=vocational*
Occupation *1=unemployed; 2=farmer; 3=house carer; 4=casual labour; 5=permanent labour;*
6= paid service; 7= own business; 8=civil servant; 9=student; 10=migrant; 11=other (specify). . . . .

Do you have any further comments, suggestions or any question?

Thank you very much for your participation and your time.

Appendix 13 – Survey to farmers: Irrigation in Mendoza, Argentina (Spanish)

Encuesta a productores: *Riego en Mendoza, Argentina*

Buenos días/buenas tardes. Mi nombre es Laura Imburgia. Estoy realizando esta encuesta como parte de una investigación de doctorado para la Universidad de Reading, Inglaterra, con colaboración del DGI (explicar). Me interesa conocer sobre las producciones de los regantes de la zona, los sistemas de riego que utilizan y cómo están organizados en inspecciones de cauce y asociaciones de riego. La información que usted provea será confidencial. Su nombre no será usado y esta conversación será sólo usada para esta investigación. Podemos detener la conversación en cualquier momento. Si no está cómodo/a con alguna parte de la conversación, por favor, no dude en decirme a mí o la persona que lo entrevista. Si tiene alguna pregunta por favor, hágamelo saber en cualquier momento. De antemano, muchas gracias.

DATOS DE IDENTIFICACIÓN

- **Información básica del entrevistado/a:**

Nombre del entrevistado/a	Género	Cód.de referencia de la encuesta
	☐ Hombre ☐ Mujer	

Lugar de nacimiento (Distrito)	Lugar de nacimiento (Provincia, país)	Rol del entrevistado/a
		☐ Propietario/a ☐ Encargado/a ☐ Mediero/a ☐ Arrendatario/a ☐ Otro______

- **Ubicación de la finca:**

Sub-distrito	Distrito	Departamento	Distancia a ruta principal (km)	Tipo de ruta (a)

(a) *Tipo de ruta: 1=ripio; 2=asfalto; 3=camino no marcado*

- **Cauce:**

AIC	IC	*Cód. de Cauce*	*Padrón parcial*	*Categoría (CD)*	*Uso (a)*

(a) Uso: 1= agrícola; 2= recreativo; 3= industrial; 4=uso público; 5=abandonado

- **Datos de la explotación**

Tipo jurídico de la explotación	¿Registrado en RENAF? (Registro de Agricultura Familiar)
☐ Persona Física ☐ Persona jurídica=> ¿Cuál? (a) ___________	☐ Sí ☐ No

(a) *Persona jurídica: SA, cooperativa, fundación, etc.*

- **Descripción del hogar del propietario/a de la tierra** (de acuerdo a la percepción del entrevistado/a)

¿Quién está a cargo del hogar?	Rol en el hogar de la persona entrevistada
1=Hombre jefe de hogar; 2= Mujer jefa de hogar; 3= Hombre jefe de hogar pero temporariamente ausente; 4=Mujer sola; 5=Hombre solo; 6=ambos jefes de hogar	*1=Jefe/a de hogar; 2=cónyuge; 3=padre-madre; 4= hijo/a; 5=yerno/nuera; 6=hermano/a; 7=otro (especificar)*

- **Información del entrevistador/a:**

Nombre	Transcripto por	Fecha de la entrevista

Parte 1: Estructura económica de la explotación

Sistema productivo

1. ¿Vive en la finca? No☐ Sí ☐ => ¿Cuánto tiempo ha vivido aquí? ________ meses/años
2. ¿Cuánto tiempo lleva cultivando esta finca? ________ meses/años
3. Superficie total de la finca ________ ha

Tipo de derecho de riego (a)	Superficie empadronada bajo riego (ha)	Superficie efectivamente regada (ha)	Superficie abandonada (ha)	Superficie para ganadería (ha)
Definitivo				
Eventual				
Precario				
Desagüe				

Superficie regada con pozo ________ ha

4. Tenencia de tierra:
   ¿Cuánta de la tierra que usa es: propia _____ ha; alquilada _______ ha; en mediería _______ha

5. ¿Tiene escritura de esta finca? Si ☐ No ☐

(a) Si su respuesta es **sí**, ¿a nombre de quién está la tierra? ___________

Referencias *1=suyo; 2=cónyuge; 3=padre; 4=madre; 5=hijo; 6=hija; 7=abuelo; 8=abuela; 9=patrón; 10= Otro (especificar) . . . .*

¿Cuánto tiempo hace que posee título de esta tierra? ________ (meses, años)

(b) Si su respuesta es **no**, ¿cuál es el estatus legal de la tierra? __________

Referencias *1=Título en trámite; 2= Sucesión; 3=contrato de alquiler; 4=No conozco el dueño de la tierra; 5=Otro (especificar). . . . .*

6. **Producción agrícola:** nos gustaría saber sobre su producción agrícola del **<u>último año</u>**
   (Completar con la información correspondiente. Ver referencias bajo la tabla):

#	Actividad productiva (*Ej. vid, olivo, frutales, hortícola otra)*	6.1. Producción				6.1.1.
		Área plantada 2016 (ha)	Rendimiento promedio (anotar unidades)	Uso familiar (a)	Uso comercial (a)	¿Cómo fue el resultado económico en 2015? (b)
1						
2						
3						

Referencias

(a) *1=todo o la mayor parte; 2=algo; 3=nada*

ϕ *La persona no sabe*

(b) *1=Cubrí costos y tuve ganancia; 2=sólo cubrí los costos; 3=no cubrí los costos*

6.2. ¿Cuánto cambió la producción en los últimos 5 años? (*Marcar con una X)*

#	Actividad productiva *(enunciadas en pregunta 6)*	Similar	Aumentó	Disminuyó
1				
2				
3				

6.3. ¿Dónde vende usualmente sus productos?

(Marque con una X. El número corresponde a la actividad productiva según pregunta 6)

#	Cultivos	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*
1	En la finca								
2	En el distrito								
3	En mercado provincial								
4	En mercado nacional								
5	En mercado de exportación								

6.4. ¿Tiene puesto propio en el mercado de concentración de la zona (en la "feria")? Si ☐ No ☐

7. **Producción pecuaria:** Ahora nos interesa saber sobre su producción ganadera (completar con el número de animales). Si no tiene animales, pase a la pregunta **8**

	Categoría	Vacunos	Ovejas	Cabras	Caballos	Cerdos	Aves	Apicultura
	Total							
1	Animal joven							
2	Hembra adulta							
3	Macho adulto							
4	Animal de trabajo							

**apicultura: n° de colmenas*

7.1. Cuánto cambió su producción ganadera en los últimos 10 años? (Marcar con una X)

	Categoría	Vacunos	Ovejas	Cabras	Caballos	Cerdos	Aves	Apicultura
1	No cambió							
2	Aumentó							
3	Disminuyó							

8. ¿Nos podría decir de qué actividades recibe ingresos? *(Marcar con una X)*

Producida por	1.Vid	2.Olivos	3. Frutales	4. Hortícola	5. Ganadería	6.Salario/ jornal	7.Ayuda de un familiar	8.Negocio propio	9.Changas	10.Rentas	11. Jubilación/ pensión	12.Asignación por hijo	13. Otro
Hombre													
Mujer													
Ambos													

8.1. De la pregunta 8, ¿de qué actividad/es recibe los mayores ingresos? *(Escriba el n. de actividad/es de acuerdo a la pregunta 8)* ______________________________

9. ¿Quién de la familia decide la mayoría de las veces sobre:

	Categoría	Decide (a)
1	¿Qué cultivos plantar? ¿Qué producir?	
2	Sobre el riego	
3	Sobre la producción animal	

Referencias

(a) 1=usted mismo/a; 2=cónyuge; 3= ambos; 4= otro (especificar). . . . .

EQUIPAMIENTO AGRÍCOLA, HERRAMIENTAS, VEHÍCULOS

10. ¿Nos podría indicar el equipamiento agrícola y maquinaria **que usa** en su producción? (*completar la tabla*)

Equipamiento/vehículos	**Cantidad** (especificar unidad o superficie)	**Propiedad (a)**
Herramientas básicas de agricultura		
Caballo/mula		
Arado, cincel, otro		
Tractor		
Pulverizadora		
Malla antigranizo (especificar n° de ha)		
Auto		
Camioneta		
Otro (especificar)*(ej. Invernadero, cultivo bajo cubierta)*		

Referencias

(a) 1=propia; 2=alquilada; 3=prestada; 4=no lo requiere; 0=no posee

ϕ *La persona no lo sabe*

CAPITAL FINANCIERO

11. ¿Usted o algún miembro de su familia tiene cuenta bancaria? Si ☐ No ☐ No sé ☐
Si su respuesta es sí, ¿a nombre de quién está la cuenta? ______________________
Referencias
(a) 1=suya; 2=cónyuge; 3=ambos

12. ¿Usted o un miembro de su familia ha pedido un préstamo en los últimos 5 años?
Si ☐ No ☐ No sé ☐

12.1. Si su respuesta es sí, ¿Podría decirnos para qué ha sido usado el préstamo? (a)
____

Referencias

(a) 1=producción agrícola; 2=ganadería; 3=vivienda; 4=uso familiar (salud; casamiento; funeral); 5=educación de los hijos; 6= Otro (especificar) . . . .

12.2. Si su respuesta es sí, ¿Quién le dio el préstamo? (a) _____________

Referencias

(a) 1=Banco; 2=financiera privada; 3=cooperativas; 4=familia o amigos; 5=Otro. . . . .

12.3. ¿Posee algún tipo de seguro agrícola? No ☐ No sé ☐ Si ☐ → 12.1. ¿Cuál?

12.4. Si la respuesta es sí, ¿ha usado el seguro en los últimos 2 años? Si ☐ No ☐

Parte 2: Manejo de recursos hídricos

AGUA

Uso doméstico

13. ¿Tiene una fuente de **AGUA POTABLE** en su finca? Si ☐ No ☐

(a) Si su respuesta es sí, ¿cuál es la fuente de agua? *(marcar con una X)*			(b) Si la respuesta es no, ¿de dónde trae el agua potable? *(Marcar con una X)*		
	Todo el año	Parte del año		Todo el año	Parte del año
1. Agua corriente de red			1. Pozo comunitario		

2. Surgente			2. Surgente		
3. Pozo			3. Entregada por la Municip.		
4. Otro (especificar)			4. Comprada		
5. Pozo			5. Pozo de un vecino		
6. Otro (especificar)			6. Otro		

13.1. ¿Ha cambiado la cantidad de agua potable en los últimos 10 años? No☐ Mejoró ☐ Empeoró ☐
13.2. Si cambió, ¿cuáles son las principales razones del cambio? *(usar reverso)*
13.3. ¿Cuánto paga por el agua potable? ____
14. ¿Usa este agua para otros usos además de beber y cocinar?
No ☐ → *salte el resto de la pregunta*
Si ☐ → Si su respuesta es sí, ¿Cuáles son esos usos?

____

(*Puede ser más de una respuesta*)

Referencias *1=riego del cultivo; 2=riego de la huerta familiar o jardín; 3=para los animales 4=higiene personal; 5= lavado de ropa; 6= limpieza; 7=Otros (especificar) . . . .*

Agua de riego

15. ¿Cuál es el origen del **AGUA DE RIEGO**? *(marcar con una X)*

	Origen del agua	Durante todo el año	Primavera	Verano	Otoño	Invierno	Nunca	No sé
1	Río (toma directa)							
2	Surgente							
3	Canal (a)							
5	Pozo comunitario (b)							
6	Pozo propio (c)							
7	Otro (especificar)							

(a) Canal: especifique el tipo de canal → matriz ☐ rama☐ hijuela ☐

(b) Pozo comunitario: Cant. de pozos _______
1. ¿Está en uso el pozo? Si ☐ No ☐
2. ¿Tiene bomba eléctrica (1) o diesel (2)? _____
3. Nos puede decir:
- Profundidad del pozo ________ metros
- Productividad (cuánta agua extrae) __________litros/hora
- Antigüedad del pozo ________ años
- Estado del pozo: ☐ bueno ☐ regular ☐ malo
- Calidad del agua para riego: ☐ buena ☐ mala (salina, contaminada)

(c) Pozo propio: Cant. de pozos _______
1. ¿Está en uso el pozo? Sí ☐ No ☐
2. ¿Tiene bomba eléctrica (1) o diesel (2)? _____
3. Nos puede decir:
- Profundidad del pozo ________ metros
-Productividad (cuánta agua extrae) __________litros/hora
- Antigüedad del pozo ________ años
- Estado del pozo: ☐bueno ☐ regular ☐ malo
- Calidad del agua para riego: ☐ buena ☐ mala (salina, contaminada)

16. ¿Utiliza esta misma agua para otros usos? Sí ☐ No ☐ → *Salte el resto de la pregunta*
16.1. Si su respuesta es sí, ¿Cuáles son esos usos? (*puede ser más de una respuesta*)

____

Referencias *1=beber y cocinar; 2=higiene; 3=uso doméstico; 4=riego del jardín y animales; 5=Otros (especificar) . . . .*

17. ¿Qué sistema de riego utiliza? (*marcar con una X o completar según corresponda)*

	Sistema de riego	Cant. de ha	Todo el año	Parte del año	¿Quién riega? *(Usted, cónyuge, contratista, etc.)*
1	A manto				
2	Por surco				
3	Por goteo				
4	Aspersión				
5	Otro (especificar)				

17.1. ¿Nos podría explicar cómo se riega en su finca? *(usar reverso si es necesario). Por ej.:*
- Turnado:
- Horario de riego:
-Cuántas personas riegan:

18. ¿Tiene suficiente agua para regar durante todo el año?
   1. Sí, casi todo el año ☐ 3. Durante bastante tiempo no es suficiente ☐
   2. Durante períodos cortos no es suficiente ☐

18.1. ¿Cómo era la cantidad de agua de riego hace 10 años?
¿Venía más agua ☐? ¿Venía menos agua ☐? ¿Era igual que ahora ☐? No sé ☐

18.2 ¿Nos podría explicar?

19. Si tiene actividad ganadera, ¿tiene suficiente agua para los animales durante el año?
   1. Sí, casi todo el año ☐ 3. Durante bastante tiempo no es suficiente ☐
   2. Durante períodos cortos no es suficiente ☐

Regulaciones legales

20. ¿Nos podría contar cómo se deciden las reglas en la inspección? Por ejemplo, turnados, presupuestos, en qué se gasta, ejecución de obras *(usar reverso si es necesario)*
21. ¿En qué cosas se ponen de acuerdo directamente (de manera informal) usted y el tomero o inspector para la distribución del agua?
22. ¿Qué tan importantes son esos acuerdos? *(usar reverso si es necesario)*
   0. No existen acuerdos informales ☐
   1. *Esenciales; sin esos acuerdos no puedo regar mi cultivo* ☐
   2. *Muy importantes* ☐
   3. *Ayudan pero no son esenciales* ☐
   4. *Poco importantes* ☐

Inspección de cauce – Participación

23. ¿Quién de su familia es el titular de la inspección de cauce? (a)__________

Referencias
(a) 1=usted; 2=cónyuge; 3= Otro (especificar). . . . .
ϕ La persona no sabe

24. ¿La persona titular de la inspección de cauce tiene alguna posición formal en la inspección? *(ej. Inspector, Comité de vigilancia, delegado, tomero)*
   Si ☐ → ¿Qué posición ocupa? . . . .
   No ☐ → ¿Nos podría explicar por qué no? . . . .

25. ¿Con qué frecuencia participa de las asambleas de la inspección? ___________

Referencias *1= siempre o casi siempre; 2= cuando necesito agua; 3= algunas veces; 4=cuando hay temas importantes para discutir; 5= nunca*

26. Ahora nos interesaría conocer algunos detalles de la inspección de cauce:

	Aspecto	Respuesta	
A	¿Qué servicios recibe de la inspección?	1. Turnado y agua ☐ 2. Limpieza de cupo ☐ 3. Ayuda técnica en riego ☐	4. Información productiva ☐ 5. Resolución de conflictos ☐ 6. Otro (especificar) ☐
B	¿Usted realiza limpieza de cupos?	Sí ☐ No ☐	Si la respuesta es **no**, ¿quién lo hace?
C	C.1. ¿Qué opinión tiene del trabajo de la inspección de cauce? *(leer las opciones)*	1. Excelente ☐ 2. Bueno ☐ 3. Regular ☐ 4. Malo ☐ 5. No estoy seguro/a ☐	C.2. ¿Por qué? *(usar reverso si es necesario)*
D	D.1. ¿Qué le parece la cantidad de agua que recibe para el riego de su finca en un año?	1. Suficiente ☐ 2. Insuficiente ☐ 3. Depende del año ☐ 4.No estoy seguro/a ☐	D.2. Si no es suficiente, ¿cuándo tiene problemas? 1. En primavera ☐ 2. En verano ☐ 3. La mayor parte del año ☐ 4. Justo antes de la terminar la corta ☐ 5. Muy pocas veces ☐
E	E.1. ¿Qué le parece el momento en que recibe el agua? *(¿La recibe cuando el cultivo lo necesita o llega a destiempo?)*	1. Muy bien ☐ 2. Regular ☐ 3. Malo ☐ 4. No estoy seguro/a ☐	E.2. ¿Esto es igual todos los años? Sí ☐ No ☐
F	¿A cuáles de estas asambleas asistió?	Mayo 2017 ☐ Octubre (presupuesto) 2016 ☐ No recuerdo☐ Ninguna ☐	
G	¿Qué opina de las asambleas?	1. ¿Son útiles? Sí ☐ No ☐ A veces ☐ 2. ¿Cuando tiene un problema se lo solucionan? Sí ☐ No ☐ 3. ¿Es buena oportunidad para ver otros regantes? Sí ☐ No ☐ Indif. ☐ 4.Otro	
H	G.1. ¿Votó por inspector de cauce en la última elección? (2014)	Sí ☐ No ☐	H.2.Si su respuesta es no, ¿nos podría indicar por qué no? *(usar reverso si es necesario)*
I	H.1. ¿A qué distancia le queda el lugar de votación?	______________	I.2.¿Esta distancia es un impedimento para votar? Sí ☐ No ☐
J	J.1. ¿Está al día con la cuota de Irrigación?	Sí ☐ No ☐	J.2. ¿Cuánto paga (aprox.)?
K	¿Qué opina sobre el monto abonado al DGI?	1.Correcto ☐ 2. Demasiado ☐ 3. Bajo ☐ 4. No sé cuánto pago ☐ 5. Si la cosecha va bien, es pagable☐	¿Por qué?

L	L.1.¿Recibe asistencia técnica de Irrigación en temas de riego y drenaje? 0. No ☐ 1. Sí, en forma regular ☐ 2. Alguna vez, algún consejo ☐	L.2.¿De dónde obtiene ayuda técnica para riego y drenaje? (otras instituciones o asesoramiento privado) *(usar reverso si es necesario)*	0. No recibo ☐ 1. Propia experiencia ☐ 2. INTA ☐ 3. Asesoramiento privado ☐ 4.Agroquímica ☐ 5. De la IC ☐ 6.Otro
M	¿Qué otros servicios le gustaría recibir de la inspección de cauce? *(usar reverso si es necesario)*		

Parte 3: Roles de género, necesidades y preferencias en la agricultura y el riego

Roles y responsabilidades de género en la producción agrícola

27. Ahora nos interesa conocer qué miembro de la familia realiza las siguientes actividades (completar según corresponda)

Actividades de producción de cultivos

		Su familia				Empleados/Jornaleros		
	Actividad	Ud. (a)	Cónyuge (a)	Chicas (a)*	Chicos (a)*	Hombre (a)	Mujer (a)	Jóvenes (a)
1	Preparación del terreno, manejo del tractor							
2	Siembra							
3	Desmalezado							
4	Plantación							
5	Riego							
6	Poda/atado de la vid							
7	Cosecha							
8	Aplicación de plaguicidas/herbicidas							
9	Aplicación de fertilizantes							
10	Preparación para el mercado							
11	Procesamiento							
12	Gestión comercial							
13	Administración y finanzas							
14	Otras							

Referencias

(a) 1=siempre; 2=algunas veces; 3=nunca

** Adolescentes*

Roles de género y responsabilidades en la producción animal

28. Ahora nos gustaría saber qué miembros de la familia realiza las actividades de cuidado de los animales. (completar según corresponda). Si la familia no posee animales, vaya a la pregunta **29**.

Actividades de producción animal

		Su familia				Jornaleros		
	Actividad	Ud. (a)	Cónyuge (a)	Chicas (a)*	Chicos (a)*	Hombre (a)	Mujer (a)	Jóvenes (a)
1	Alimentar a los animales							
2	Cuidados veterinarios							
3	Ordeña u otro manejo productivo							
4	Venta-compra de animales							
5	Procesamiento de productos							
6	Comercialización							
7	Administración y finanzas							
8	Otras							

Referencias

(a) 1=siempre; 2=algunas veces; 3=nunca

** Adolescentes*

Roles de género y responsabilidades en el trabajo del hogar

29. Ahora nos gustaría saber con qué frecuencia los miembros de su familia realizan los siguientes trabajos:

		Su familia				Empleados		
	Actividad	Ud. (a)	Cónyuge (a)	Chicas (a)*	Chicos (a)*	Hombre (a)	Mujer (a)	Jóvenes (a)
1	Cocinar y limpieza del hogar							
2	Construcción/reparación de vivienda							
3	Manejo del agua potable (si no hay agua corriente)							
4	Cuidado de los niños/ancianos							
5	Ayuda con las tareas escolares de los niños							
6	Producción de huerta familiar							
7	Pago de cuentas y gestiones bancarias							
8	Otro (especificar)							

(*)adolescentes

Referencias

(a) 1=siempre; 2=algunas veces; 3=nunca

Parte 4: Preferencias y necesidades

30. ¿Nos podría indicar cuáles son los principales problemas productivos siguientes en su finca?
31. ¿Cuáles son sus principales problemas con el riego?
32. ¿Cuáles son los principales problemas para vender sus productos?

Parte 5: Datos demográficos y educación

33. ¿Nos podría dar información sobre las personas que viven en su casa, incluida/o usted? *Ver referencias*

	Relación con usted	Edad	Género	Estado civil	Educación	Ocupación
1	Usted mismo					
2						
3						

Referencias

Género *1=hombre; 2=mujer*
Estado civil *1=casado/a 2=soltero/a; 3=viudo/a; 4=divorciado/a*
Educación *1=sin educación; 2=primaria incompleta; 3= primaria completa; 4=secundaria; 5=post-secundaria; 6=técnica*
Ocupación *1=desempleado/a; 2=productor/a; 3=ama de casa; 4=jornalero/a; 5=empleo permanente; 6= servicio por horas; 7= negocio propio; 8=empleado estatal; 9=estudiante; 10=migrante; 11=otro (especificar) . . . .*

¿Tiene algún comentario o sugerencia adicional? ¿Alguna pregunta?
Muchas gracias por su participación y su tiempo.

C. Letters of introduction and consent form

Appendix 14 – Letter of permission to conduct fieldwork in Tigray

ኣብ ብሄራዊ ክልላዊ መንግስቲ ትግራይ ቢሮ ሃፍቲ ማይ
በትግራይ ብሄራዊ ክልላዊ መንግስት የውሃ ሃብት ቢሮ
The Government of National Regional State of Tigray, Bureau of Water Resources

ቁፅሪ Ref.No 4129/3342/4-19 ዕለት Date 24 ሀ%C 2008

ናብ ዝምልከቶ ኩሉ

ዋኒኑ- ናብ ደ.ጋፍ ምሃብ ይምለከት

ኣብ ዋኒት ንምግላፅ ከም ዝተፈተነ ኣብ ዩናይትድ ኪንግዶም ናይ ሬንዲግ ዩኒቨርስቲ ናይ ዳክትሬት ዲግሪ ተማሃሪት ዝኾና ወ/ሮ ላዉራ ኢሞቡርግያ Water governance and dynamics of gender amongst water users ብዝብል ርእሲ ኣብ ራያ ቫሊ ኣብ ዝርከባ ወረዳታት ፅንዓት ንኸካይዳ ድ.ጋፍ ክግበረለን ካብ ዩንቨርሰተን ናብ ቢሮና ብዝተፀሓፈ ደብዳቤ ተሓቲትና ኣለና። በዚ መሰረት እዘን ሽመን ኣብ ላዕሊ ዝተገለፃ ግለሰብ ኣብ ራያ ከባቢ ዝርከባ ወረዳታት ዘለዋ ናይ ማይ ኮምቴታትን ካልኦት ናይ ወረዳ ሃ/ማ/ማ/ኢ.ነርጅን ኣካላትን እናረኸባ ፅንዓተን ንኸካይዳ ኣድላይ ትሕብብር ንክግበረለን እናሓተትና ንዝግበረለን ደ.ጋፍ ኣቐዲምና ነመስግን።

ምስ ሰላምታ

መላኩ እስጢፋኖስ ኣብርሃ
Melaku Estifanos Abraha
ወናኒ ኣውራ ከይዲ በራሕ ...
ቁፅፅርን ሃፍቲ ...
Process Owner ...
Resource Managem...
Regulatory

Appendix 15 – Letter of introduction to fieldwork

University of Reading

SCHOOL OF AGRICULTURE POLICY & DEVELOPMENT THE UNIVERSITY OF READING

School of Agriculture, Policy and Development
Agriculture Building
Earley Gate
Reading RG6 6AR

Phone:
Email:

10 November, 2015

Re: Letter of Introduction

Dear Sir or Madam,

This is to introduce Ms. Laura Imburgia, a doctoral candidate at the University of Reading, England, who is conducting field research regarding water governance and dynamics of gender amongst water users. She hopes to uncover the decisions that are made about water governance, how people access water and the different ways of supporting access to water. As gender equality is being strongly promoted the findings of this research can support devising more equitable sector policies. Likewise, strengthening water users' participation in water governance can be beneficial for agricultural development in areas suffering water scarcity.

Ms. Imburgia will be conducting field research from November 2015 until February 2016 in Tigray (Raya Valley). She has arranged to meet with several Ministerial officials to learn about water sector policies in Ethiopia; agricultural and irrigation current development and projects and programmes being implementing under the corresponding Ministries. She will also be meeting with local officials to listen as they describe the implementation of local irrigation programmes. As part of her research she would also very much like to meet with non-government organisations, rural service enterprises, and with male and female farmers associated to water users'organisations. We would very much appreciate whatever assistance you can offer.

While Ms. Imburgia is conducting her field research, she is under my supervision and in contact with me and her second supervisor.

Ms. Imburgia is an Italian/Argentinean citizen; she is also a resident in Ethiopia (ID: ET/008/13B, valid until 17 February, 2017). She has been studying at the University as of September 2014. Her contact phone number in Ethiopia is Should you wish to discuss her research aims or objectives further, please do not hesitate to contact me at or by calling +

Thank you for any assistance you are able to provide to her.

Yours sincerely,

Dr. Sarah Cardey
Director, Graduate Institute for International Development and Applied Economics
Lecturer in International Development

Appendix 16 - Information sheet and consent form for anonymous participation in individual and group interviews – Ethiopia

Research project: ***Livelihood processes of gender roles and relations in water governance - Comparative study in Ethiopia and Argentina***

My name is Laura Imburgia. I am a PhD student at University of Reading, in UK. I am conducting a comparative, trans-regional study in which I investigate issues of social relations in water governance (irrigation) with the aim at elucidating whether it is possible to find similar patterns in water access, control and participation, and to identify participation opportunities across different cultural and socio-economic settings. I am conducting this research in Ethiopia and Argentina. Through this research I would like to learn about the agricultural activities of farmers, men and women, of Raya Valley; their irrigation practices and how they are organised to work with other farmers in water user associations.

Your participation in this study would consist of taking part in a survey by the primary investigator with support of a local translator. Interviews will last one hour and a half as maximum. The locations and time for the interview will be agreed according to your convenience.

This study has no relationship with any government or NGO programme of Ethiopia or elsewhere. All the information that participants provide, including conversations, notes and audio recordings will remain confidential, and in the sole possession of the primary researcher. The information will be used for the sole purpose of this research. Your identity will not be revealed to anyone other than the interviewer collecting your consent form. A reference code will be assigned to protect your identity. All information collected for this research will be kept for a period of five years under protected conditions as a requirement of the University of Reading. Findings from this research will be made available after completion of the study to any participant that wishes to see them.

You are free to stop this interview at any moment and withdraw from the interview without providing any reason. If you are not comfortable with any part of the conversation or unwilling to participate please let me know. You can also avoid answering any question that you do not feel comfortable with. Also if you have any question please do not hesitate to ask me at any moment. Any of your contributions can be withdrawn at any stage and removed from the research if desired.

Written records, audio recording and research notes will be secured in the possession of the primary investigator. All data stored in electronic form on a computer will be kept win a password-protected file, whose password is known only by the primary investigator.

If at any stage you would like to receive further information about the questionnaire or the project please do not hesitate to contact the primary investigator:

Laura Imburgia
School of Agriculture, Policy and Development, University of Reading. RG6 6AY.
Phone: (Ethiopia)
E-mail:

Or her supervisor:

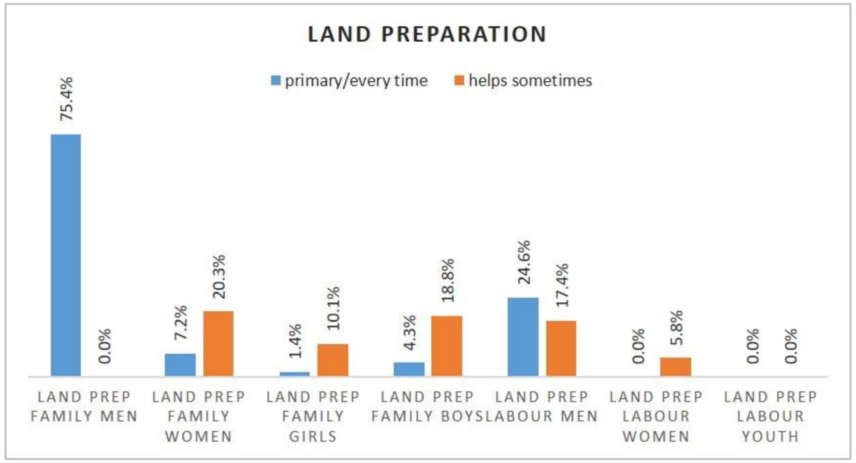
Dr. Sarah Cardey
School of Agriculture, Policy and Development, University of Reading. RG6 6AY.
Phone:
E-mail:

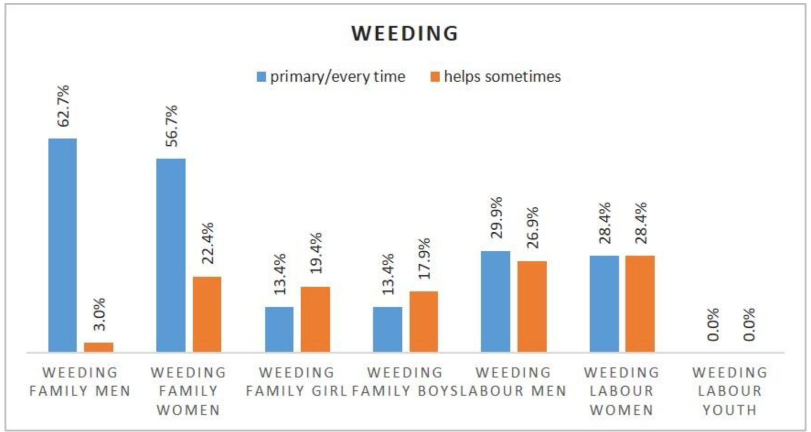
By answering the interview questions you are acknowledging that you understand the terms of participation and that you consent to these terms.

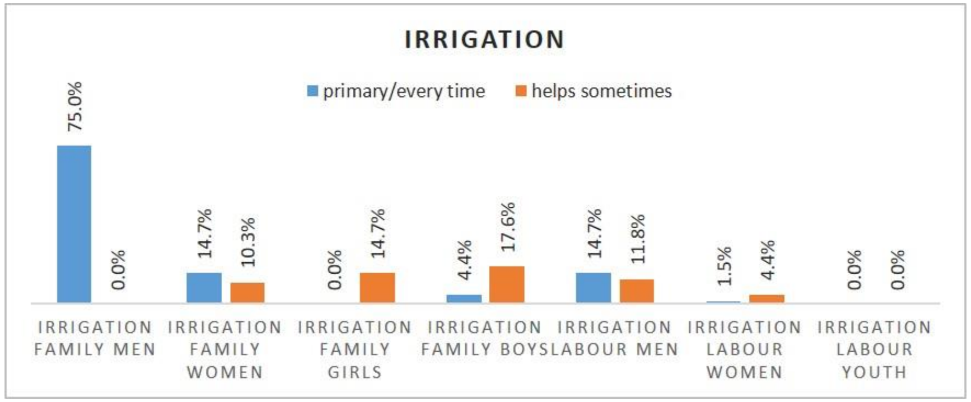
The research study and this application have been reviewed according to the procedures specified by the University of Reading and has been given a favourable ethical opinion for conduct.

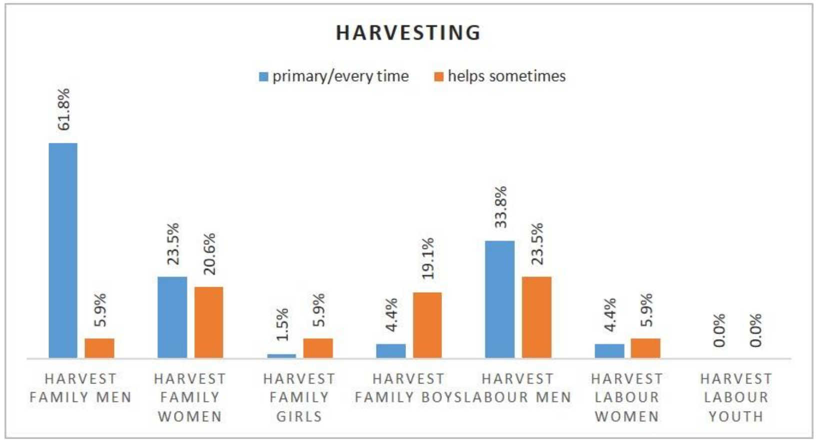
D. Additional results

Appendix 17 – Gender division of roles in selected farming tasks within the household- Tigray



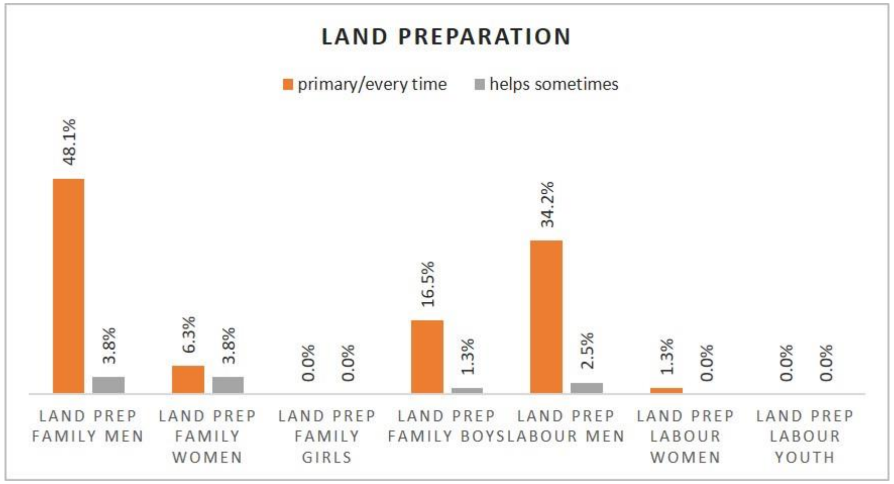


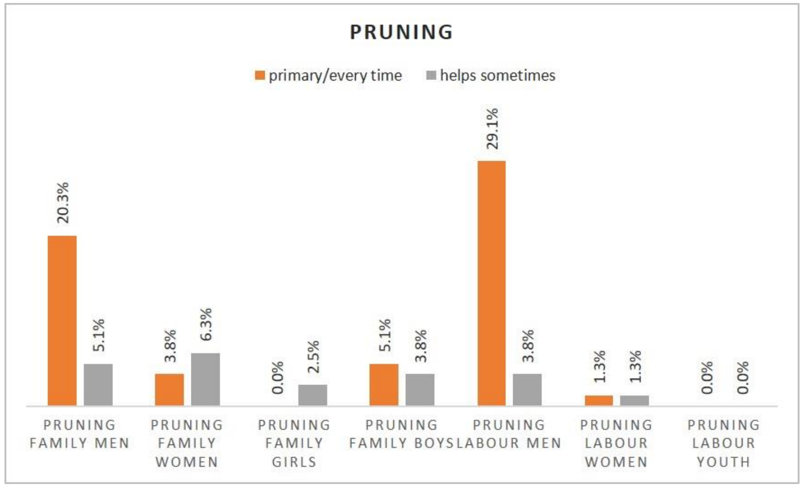


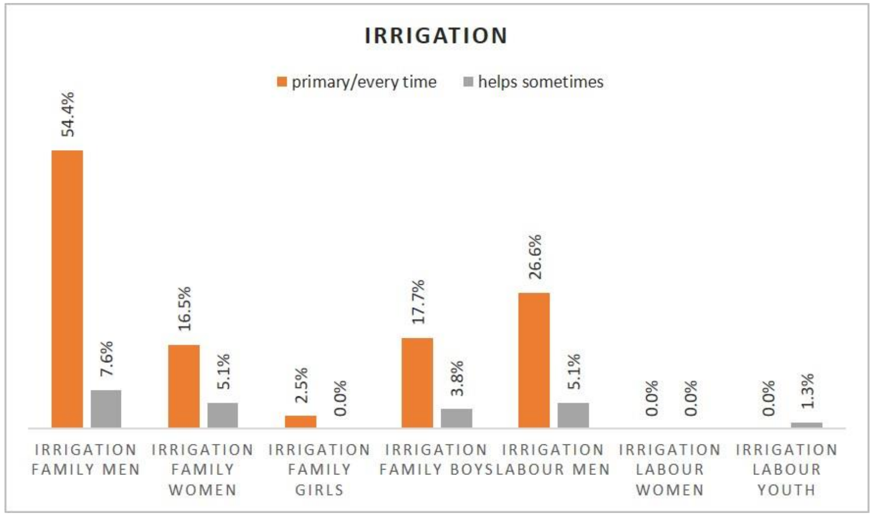


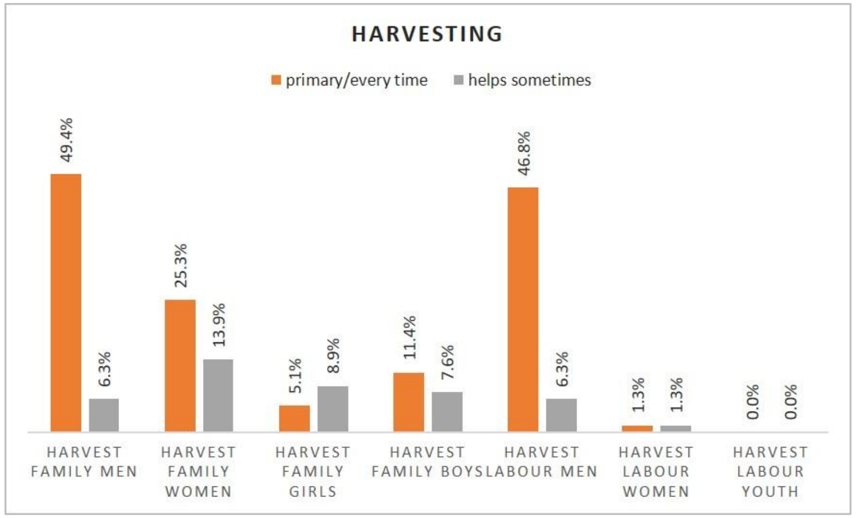
Source: Survey of farmers in Tigray, January-February 2016; March 2018. N=68. Survey participants were asked who in the household performed each activity.

Appendix 18 – Gender division of roles in selected farming tasks within the household - Mendoza



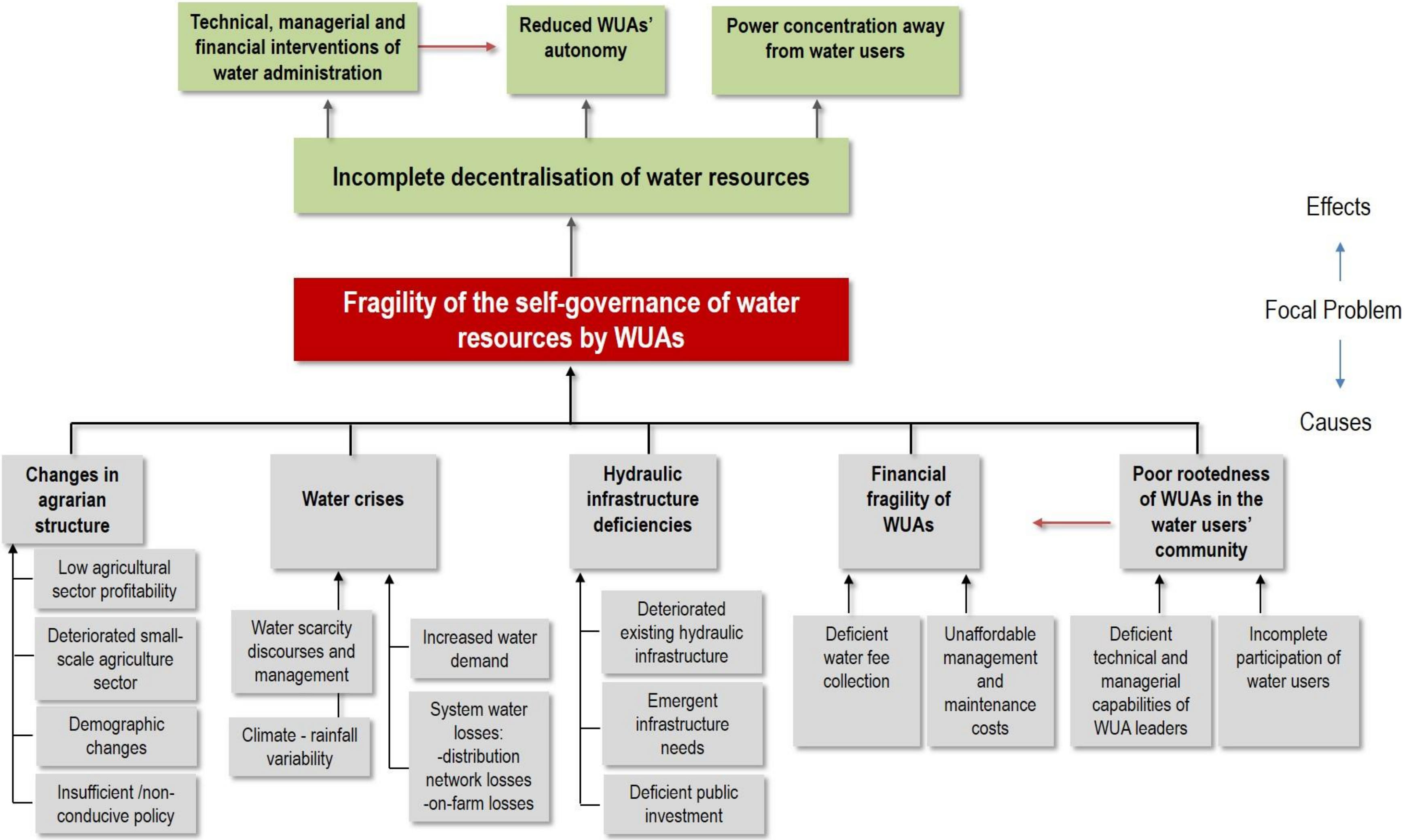






Source: Survey of farmers in Mendoza, July-December, 2016; May–June, 2017. N=79. Survey participants were asked who in the household performed each activity.

Appendix 19 - Problem tree analysis example of self-governance of irrigation water resources



Source: Developed by the author. Method based on DFID (2003).

E. Additional publications

Appendix 20 – Publication in Agriculture for Development

Agriculture for Development, 33 (2018)

News from the Field

Women farmers till the land to protect agricultural heritage and change ways of living

Introduction

In recent decades, the concept of *participation* became an important, even a required, element of development policy for natural resource management – the intention is to ensure more equitable and more sustainable resource conservation and development by involving resource users at all levels of decision-making in planning and management (Cornwall, 2003). However, at the same time, participatory governance of natural resources has been criticised for failing to improve resource management, and actually worsening sustainability and inequality problems. Institutions that are 'participatory' by definition can produce 'participatory exclusions' due to structural factors including rules of entry, social rules and perceptions, and personal and household characteristics (Agarwal, 2001). While access to water is essential for all, many rural women seem to be affected disproportionately by unequal participation in decisions concerning the use and management of irrigation systems. In many irrigated areas of the world, women are poorly represented in water user associations (WUAs), especially in influential positions (Yami, 2013; Udas, 2014; Buisson *et al*, 2017). This imbalance in participation has practical implications, which become particularly apparent in the small-scale irrigation sector. The diverse water needs of men and women seem to be not appropriately considered. This relates to crop and livestock production (type of crops, market integration, family household needs) but also to the planning and maintenance of irrigation infrastructure. Additionally, women are less frequent recipients of extension services related to technical aspects of irrigation and water management.

Irrigation management systems in Mendoza Province, centre-west Argentina

The irrigation management sector of Mendoza Province provides an example of how even in a technically robust and well-established water management system, gender-based constraints to participation and decision-making by women persist. This case illustrates opportunities to address gender inequalities.

In recent years, Mendoza Province has experienced a water crisis precipitated by a prolonged period of drought. Agriculture in this arid region, mostly production of wine, fruit and vegetables, is only possible under irrigation. The structure of the farming sector is dominated by small and medium size, mostly family-unit producers (60 percent of irrigated farms have 4 hectares or less of cultivated land). Profitability of agriculture has decreased due to economic and political factors, exacerbating the effects of drought. In response, the Water Resource Department in charge has implemented a series of changes aimed at strengthening the resilience of the water management system, with focus on the decentralisation of management and devolution of decision-making.

Constraints to the participation of women in irrigation management

The participation of farmers is regulated by a management system codified over a century ago. The almost 100,000 water right holders of the province are organised in 142 non-government WUAs with financial autonomy and legal capacity to enforce surface water policy. Only two of them are led by female farmers. Although the central water administration employs relatively more women (about 20 percent), they occupy primarily administrative positions; few hold engineering positions, and only in early 2017, was the first woman appointed to a senior management position. A number of gender differences in agriculture may explain this extremely low participation of women in the management of the irrigation sector:

Even when holding formal water rights, many women do not assert those rights; local cultural practices still favour men who dominate the usufruct and decision-making over the economic value of water. In Mendoza, the Provincial Water Law (sanctioned in 1884) stipulates that formal water rights are inherent to land rights. Water rights can only be realised through participation in WUAs. An analysis of the registered names of 2,123 land titles, correlated with agricultural water rights in nine WUAs, showed that an average of 31 percent of the titles were registered in the name of women. Results from a survey conducted on a sample of male and female farmers from those nine WUAs showed that only 22 percent of the land titles were in women's names alone, and 6 percent in joint titles. However, a land title in the name of a woman does not necessarily mean that she is the one who is farming and/or making the agricultural decisions. In the farms owned by women alone or jointly with a man, many of the farming decisions were made by husbands or male relatives, as indicated in 53 percent of the cases; in 36 percent of the cases, women shared decisions with a household male; and only in 11 percent of those cases of women owning land, were farming decisions made only by women.

Traditional gender roles in agriculture still define an invisible role for women, who tend to be engaged in usually unpaid employment in agriculture. Irrigation as a male domain may be partly explained by the traditional gender division of labour in agriculture, with men being in charge of the more physically demanding jobs and those distant from the households, and women responsible for lighter duties close to the home (Momsen, 2010). Interviews showed that in households where the man is considered the farm head, the woman identifies herself as a helper. It was reported that women were less involved in land preparation (10 percent of the cases) and application of pesticides (10 percent). Women were found performing irrigation tasks in 23 percent of the cases (usually controlling proper distribution of irrigation water along the field crop by opening and closing furrows by moving soil with a hoe). Other farming tasks showed higher levels of female involvement, *eg* sowing and planting (32 percent), weeding (29 percent) and harvesting (53 percent). As for off-farm activities, in 28 percent of the cases women were involved in produce marketing. In 48 percent of the cases, women were responsible for farm administration and paperwork. In domestic chores, women were exclusively responsible for cooking and cleaning in 69 percent of the cases; in the remainder of cases they stated having the help of a male household member. In households with responsibilities for the care of children and elders, women were found exclusively in charge in 52 percent of the cases, and sharing responsibilities with husbands or male kin in 37 percent of cases. Men carried exclusive responsibility for these tasks in only 11 percent of the cases. While men were responsible for certain other domestic tasks, such as small maintenance repairs (84 percent), these do not occur regularly and present much smaller time demands.

Women today have relatively lower participation in the small-scale agricultural sector of Mendoza, partly explained by the very low profitability of farming. Rural women in Mendoza recognise having worked much more in farming in the past. Reasons are evident: the current low profitability of farming (together with the high cost of living) obliges men and women to search for jobs outside the home. The annual irrigation water fee has become too high for the current profit margins of small-scale agriculture. Also, the required labour contribution to irrigation infrastructure maintenance usually involves extra labour costs for women, since such tasks as canal cleaning require rather heavy physical work, so women hire labour for these duties. Many women now favour less physically demanding jobs with more economic security, although it seems to be more challenging for rural women to find appropriate job opportunities off-farm.

Cultural practices and social norms still prevent many women from undertaking activities related to irrigation system management. Interviewees indicated that it is usually harder for women to access leading positions and to see their knowledge and capacity recognised in the irrigation sector. This is not exceptional. Evidence from other locations also show that women claiming participation in the male dominated sector of water resource governance often have to confront culturally rooted ideologies and power structures, often at a personal cost (Vera Delgado, 2005 in Peru; Giarracca and Del Pozo, 2005 in Argentina). Male dominance in the engineering and irrigation professions may partly explain this gender segregation (Zwarteveen, 2011). Despite a much higher awareness of gender-based constraints for rural women in Mendoza today – in particular those related to domestic violence – male (and some female) water resource management officials and leaders of WUAs generally seem to have a poor understanding of causes and consequences of structural gender inequalities in the sector. Neither the Provincial Agricultural Ministry and its research and extension institutions, nor the Provincial Water Office, have specific gender equality policy frameworks in place.

These constraints notwithstanding, many rural women with primary family responsibilities, relatively less mobility than men, and lacking education and resources for entering other economic sectors, still find in agriculture a main source of employment. For example, farming has provided female farmers in intensive vegetable production areas of Mendoza the opportunity to work close to their homes, securing a decent income and expanding their farming knowledge through training support received by the local agricultural extension agency (Figure 1). Another group of interviewed women has recently developed their own wine production line (Figure 2) in an effort to develop an independent livelihood diversification alternative to the very low returns realised in grape production.

Figure 1. Research session with women producers of fresh vegetables to supply the city of Mendoza (May, 2017).

Figure 2. Launch of the 'Wine of Women' during a local farmer's market, Mendoza (October, 2017).

Conclusions

Through their participation in this study, women could access more information regarding the functioning of the WUAs and the irrigation management sector. As a result, many of them indicated a growing interest in attending the WUA meetings and seemed more assertive about voicing their claims and issues with water. These issues included improper water distribution, water robbery and bribery and corruption in water distribution. While these problems are not pervasive, according to field reports and observations they appeared to be disproportionally affecting poorer (less powerful) small-scale farmers, particularly women.

These examples suggest the value of improving the participation of women in the irrigation management sector. A number of emerging opportunities are promising. WUAs, with clear rules and regulations, but with flexibility to accommodate the needs of different irrigation groups, including women, seem to better secure water for its members and reduce participation inequalities. These associations should be enabled to provide support to farmers in improved agricultural and irrigation practices and market information.

There is a need for cultural change in order to allow more women in irrigation management, not only in quantity but also in terms of meaningful participation. Improving the income level of women in farming, strengthening their technical knowledge, improving their access to information and extension services, and devising policies to explicitly support small-scale agriculture, are essential steps to reach this goal. While this call may have been voiced before, its explicit resonance in development programmes remains low.

Finally, gender integration policies, at present weak and scattered in the agricultural sector, and non-existent in the water management sector, are needed in Mendoza. Within the traditionally male-dominated water institutions, there is a clear need to educate water management officials to recognise the capacity of women in technical and management positions in water management. Raising the number of women employed (for example through establishing a female quota), while also addressing their capacity development needs, and involving specific expertise in this kind of process, can also help to collectively develop ways to increase the number and effectiveness of women participating in irrigation management.

Acknowledgements

The research project described was partly supported by the Water Resource Department of Mendoza Province (*Departamento General de Irrigación*) within the study: *The role of water users' associations in the economic development of Mendoza. Conditions and opportunities in decentralisation and devolution* (2017).

References

Agarwal B, 2001. Participatory exclusions, community forestry, and gender: An analysis for South Asia and a conceptual framework. *World Development*, **29**, 1623-1648.

Buisson MC, Curnow J, Naz F, 2017. The gender gap between water management and water users: evidence from Southwest Bangladesh. *South Asian Water Studies*, **5**, 28-41.

Cornwall A, 2003. Whose voices? Whose choices? Reflections on gender and participatory development. *World Development*, **31**, 1325-1342.

Giarracca N, Del Pozo N, 2005. La lucha por los derechos del agua en Tucumán. Transnacionales y mujeres en la protesta social. *Alianza Estudio*, **58**. Universidad de Buenos Aires.

Momsen JH, 2010. Gender and development. 2nd ed. London: Routledge.

Udas PB, 2014. *Gendered participation in water management in Nepal: Discourses, policies and practices in the irrigation and drinking water sectors.* Wageningen, Netherlands: Wageningen University, PhD thesis.

Vera Delgado J, 2005. Irrigation management, the participatory approach, and equity in Andean community. In: Bennett V, Dávila-Poblete S, Rico N, eds. *Opposing currents: The politics of water and gender in Latin America.* Pittsburgh: University of Pittsburgh Press, 109-122.

Yami M, 2013. Sustaining participation in irrigation systems of Ethiopia: What have we learned about water user associations? *Water Policy*, **15**, 961-984.

Zwarteveen M, 2011. Questioning Masculinities in Water. *Economic and Political Weekly*, **18**, XLVI.

Laura Imburgia

Laura is a PhD researcher in livelihoods, gender and water resource management at the School of Agriculture, Policy and Development, University of Reading. She holds a MSc degree in International Agricultural Development from UC Davis. She has worked as technical advisor in rural development and agriculture for over 17 years.

l.imburgia@pgr.reading.ac.uk

This publication contains a summary of a minor part of the study.

Reference: Imburgia, L. (2018). Women in irrigation management in Argentina: participation and opportunities. *Agriculture for Development. Tropical Agriculture Association* **Spring 2018**, 30-33.