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New Possibilities for Women's Empowerment through Agroecology in Himachal Pradesh, India

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Abstract: In 2018, the state of Himachal Pradesh in north India launched an initiative to convert all its farmers to natural farming (NF), an agroecological approach. The aim was to address multiple challenges related to rural livelihoods, high input costs, biodiversity loss, and environmental degradation. This paper is based on a qualitative case study of the state programme to transition farmers to NF. It seeks to understand how its mechanisms support and empower small and marginal women farmers. In addition to identifying mechanisms that facilitate the effective uptake of NF, the case study sought women's views on whether these mechanisms increased spaces for decision making and developed capabilities and autonomy. Framed within the vision of reclaiming food sovereignty, various mechanisms such as training in villages, participating in NF groups and networks, visits to model farms, and adopting leadership roles offered new pathways for women farmers to gain confidence and capabilities. Women began to participate in spaces that had been culturally and structurally denied to them. This case study demonstrates how agroecology initiatives, with a particular emphasis on gender, can offer women various opportunities for decision making, income generation, and creative expression. These initiatives also expand community agency and enable the acquisition of knowledge necessary for sustainable ecosystems.

Keywords: gender; Himachal Pradesh; transition; empowerment; food sovereignty; farmer networks; marginal farmers

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1. Introduction

Natural farming (NF) is an agroecological approach that can potentially address multiple agricultural crises attributed to the industrial farming model [1,2]. The use of high-cost agrochemicals has not only placed farmers in debt but has polluted the environment, degraded the soil, and affected people's health adversely. In India, NF is being adopted for its potential to regenerate the soil, increase farmer incomes, enhance food security, and enhance resilience to climate change. This paper uses a case study of a natural farming initiative by the north Indian state of Himachal Pradesh to explore how its mechanisms support and benefit small-scale and marginal women farmers. In India, research on agroecology and gender has been limited to NGO reports [3]. Agarwal's [4] significant research on how group farming empowers women did not examine farming practices. An emerging body of literature from Latin American countries bridges agroecological and gender scholarship, but relatively little has been published in English [5–7]. There is a need for evidence-based research that explores the processes of change and the impact on women from their perspectives so that the complexities of their day-to-day lives are understood. This paper asks whether state mechanisms in India support women transitioning to NF, and whether these expand spaces for decision making and build capabilities to make effective choices to improve their lives.

The paper begins with a literature review that discusses key concepts in agroecology and women's empowerment. Exploring the different academic framings and shifts that

have taken place within the literature will make evident how agroecology and gender studies share common ground related to justice and equity.

2. Literature Review

2.1. Agroecology as a Sociopolitical Movement

The first argument the paper makes from the literature is that the concept of agroecology has evolved from that of longstanding traditional practice and the science of sustainable farming into a discourse about whole food-system transformations and food sovereignty. Currently, multiple agroecology initiatives in India address the fallout from the Green Revolution (GR) technologies. The GR, an industrial model of agriculture comprising hybrid seeds, fertilisers, pesticides, irrigation, and mechanisation, was exported from the USA to India in the 1960s. It was resource-intensive, and, in India, it resulted in the marginalisation of small-scale farmers, soil degradation, water depletion, deteriorating human health, loss in biodiversity, and farmer indebtedness [8–10]. In 2018, the states of Andhra Pradesh and Himachal Pradesh began an ambitious plan to transition all their farmers from conventional chemical farming to NF. NF refers to low-cost regenerative agricultural practices based on ecological principles that do not rely on agrochemicals. A National Coalition of Natural Farming (NCNF), a network of 400 organisations, was established "to accelerate the practice and policy related to agroecology-based farming in its multiple variants in India" [11]. The NCNF aims to empower small and marginal farmers with an emphasis on women farmers, which is of particular significance in India, where 63% of working women work in agriculture within oppressive patriarchal, caste, and cultural norms [12].

Agroecology remains a contested term in its definition and scope. Altieri's well-known description of agroecology as an ecosystem approach that applies ecological concepts and principles to the design and management of sustainable agroecosystems has been expanded to include increasingly political spaces, using food sovereignty and food justice perspectives to transform food systems [13,14]. This sociopolitical dimension was facilitated by the emergence of agroecology as a sociopolitical movement. In opposition to high-input GR technologies and the "modernisation" agenda imposed on developing countries by the World Bank and International Monetary Fund, La Via Campesina, a transnational peasant organisation, proposed an alternative agriculture and rural development model framed as food sovereignty. This was adopted in 2007 by advocates from 80 countries [15,16]:

> *"Food sovereignty includes the right to food—the right of peoples to healthy and culturally appropriate food produced through socially just and ecologically sensitive methods. It entails peoples' right to participate in decision-making and define their own food, agriculture, livestock and fisheries systems. It defends the interests and inclusion of the next generation and supports new social relations free from oppression and inequality between men and women, peoples, racial groups and social classes"* [17].

Subsequently, the Declaration of the International Forum for Agroecology, held in Nyleni in 2015, accepted agroecology as a key element in constructing food sovereignty. In asking for a transition to more sustainable food systems, this approach asks for a more just society that counters structural oppression, racial capitalism, and patriarchy [18]. Further, Schneider and McMichael [19] argued that food sovereignty has a significant role as an environmental countermovement needed to resolve ecological crises. It achieves this by repairing the relationships between people and nature and restoring the "epistemic rift" caused by industrial agriculture, i.e., a rupture in the farmers' knowledge needed for sustainable ecosystems.

The question of how to scale agroecology up and out has become an increasingly important debate in global policy and funding spaces that address food systems, such as UN climate and biodiversity conferences and the UN Food Systems Summit [20–23]. Gliessman's five transition levels form a widely used framework to understand how farmers can transition from conventional farming (CF) to an agroecological system [18]. Gliessman borrowed the first three levels from Hill [24], focusing on the technical aspects

of transitions from CF to fully integrated agroecological systems at Level three. He added two further levels to include a broader food system change and food sovereignty (Table 1).

Table 1. Transition stages to agroecology with examples (adapted from [25] (p. 51), [26]).

	Gliessman's levels of transition		**Examples**
Transformational	Level 5—Build a new global food system based on participation, localness, fairness and justice.	*Food system*	Supporting and expanding farmer seed systems. Restoring and protecting ecosystems based on equity and democracy.
	Level 4—Reconnect consumers and producers through the development of alternative food networks.		Community supported agriculture (CSA), participatory guarantee schemes (PGS), direct marketing.
	Level 3—Redesign the agroecosystem based on a new set of ecological processes and protect biodiversity.	*Agroecosystem*	Intercropping, permaculture, agro-sylvo pastoral farming, natural farming.
Incremental	Level 2—Substitute conventional inputs and practices with agroecological alternatives.		Organic farming in monocultures.
	Level 1—Increase efficiency of input use and reduce use of costly, scarce or environmentally damaging inputs.		Smart agriculture, precision farming, optimal crop spacing, drip irrigation.

Although Gliessman's transition levels represent a stepwise evolutionary process towards food systems transformation, several overlaps and entry points may exist. As was observed in Himachal Pradesh, NF is an example of a Level 3 systems redesign (also noted in Andhra Pradesh [27]), where some farmers, such as those with established fruit orchards, begin with input substitution using the Palekar formulations. Success with these encourages further experimentation, and farmers transition to the next level. Anderson et al. [18] argued that a Level 3 redesign would be challenging unless farmers are supported by broader structures and relationships such as food markets, reciprocity within the community and wider landscape changes found at Levels 4 and 5. In Himachal Pradesh, features of Level 4 wider community and food systems change were present: the transitions involved new relationships and forms of social organisation, participatory forms of learning, and communities sharing resources similar to those observed in Andhra Pradesh [27,28].

In 2021, concerns that mainstreaming agroecology would deprive it of its political and social underpinnings, which distinguish it from other sustainable agricultural practices, led to the formation of the Agroecology Coalition [22]. To define agroecology more precisely, it adopted the 13 principles of agroecology suggested by the High-Level Panel of Experts (HLPE) [25] of the Committee of World Food Security. These principles include the ten elements of agroecology from FAO [29] and can be related to Gliessman's transition levels. The first seven principles—(1) recycling, (2) input reduction, (3) soil health, (4) animal health and welfare, (5) biodiversity, (6) synergy (managing ecological interactions), and (7) economic diversification—relate to Levels 1 to 3. The next six principles relate to whole food-systems changes: (8) co-creation of knowledge (embracing local knowledge and global science), (9) social values and diets, (10) fairness, (11) connectivity (between producers and consumers), (12) natural resource governance, and (13) participation.

2.2. The Need for a Gender Focus in Agroecology Transitions

The second argument this paper derives from literature is that transitioning to agroecological farming alone may not be enough to overcome the barriers women face due to their invisibility and subordination [30]. While agroecology's principles and theoretical underpinnings are based on promoting equity, its practice does not always reflect this [31,32]. In agroecology movements that do not promote initiatives specifically for women, women are seen to be present, but only as farmers' wives. This was evident in a study of the ZBNF movement in Karnataka, India, despite being led by a grassroots movement [33]. For agroecology to be transformative, a synergistic relationship between agroecology and the feminist movement is needed [34]. In instances where a gender focus has been included in

agroecology approaches, the findings show enhanced life outcomes and empowerment for women [35].

Empowerment can be understood as gaining a sense of power to shape the lives we want to live ourselves and the lives of others [36]. It is generally agreed that empowerment is a multi-dimensional concept that includes relational power as an essential aspect. It can be expressed through dominating others, resisting transformative change, or generating new possibilities through collaboration. Power relations function in multiple domains—domestic, social, and political. Additionally, what may be experienced as empowering for one woman may not be empowering for another. How interventions change women's lives depends on their circumstances, the possibilities open to them and what they value [37,38]. The process, in essence, is one of self-determination. To understand how changes in power happen, it is helpful to distinguish between different types of power (Table 2).

Table 2. Distinguishing different types of power (adapted from Bradley and Rowlands [39,40].

Types of Power	Meaning
Power over	The power that people wield over others, such as that of men over women, and that of dominant social, political, economic, or cultural groups. Resisting "power over" entails an understanding of the dynamics of oppression, particularly internalised oppression.
Power within	A sense of self-worth and self-respect, where people see themselves as able and entitled to make choices.
Power to	A generative term, which refers so the realm of creating new possibilities. It is one's power to act, speak out, and make choices to shape one's own life.
Power with	One's social abilities to act in a group, where one can gain strength in working as a collective or in alliance with others.
Power for	People's vision and values to create a world in which they want to live. It inspires and motivates people to persist with their efforts towards that end.

The types of power are interlinked and complementary. For example, "power within" lies at the crux of empowerment and forms the basis of the other categories. In turn, an increase in one's capability to resist "power over" or enhancement of abilities in the social domain, i.e., "power with", strengthens the "power within". The importance of "power within" or a woman's self-confidence and self-view is highlighted by Belenky et al., [41] who argued that a woman's confidence in herself as a thinker and the belief that she is capable of intelligent thought lies at the basis of her ability to make choices for her well-being. These understandings reinforce the need for an intentional equity focus in agroecology efforts. Amartya Sen [42] (p. 125) noted, "the issue of gender inequality is ultimately one of disparate freedoms". Gender equality and women's empowerment are considered to be integral to each of the 17 Sustainable Development Goals [43].

Cornwall [36] emphasised the need for change at all levels—personal, social, and institutional as shown in the framework below (Figure 1) for gender equality and women's empowerment to be achieved. She argued that providing women with resources, economic opportunities (Quadrant B) and supportive institutional policies (Quadrant D) were insufficient conditions for transformation. A process for a change in consciousness (Quadrant A) is also required in the way women perceive the world and their roles so that they become aware of inequalities and limiting social norms [36,44]. Quadrant C refers to deep cultural beliefs that exert 'power over' people's actions and are often the most difficult to change.

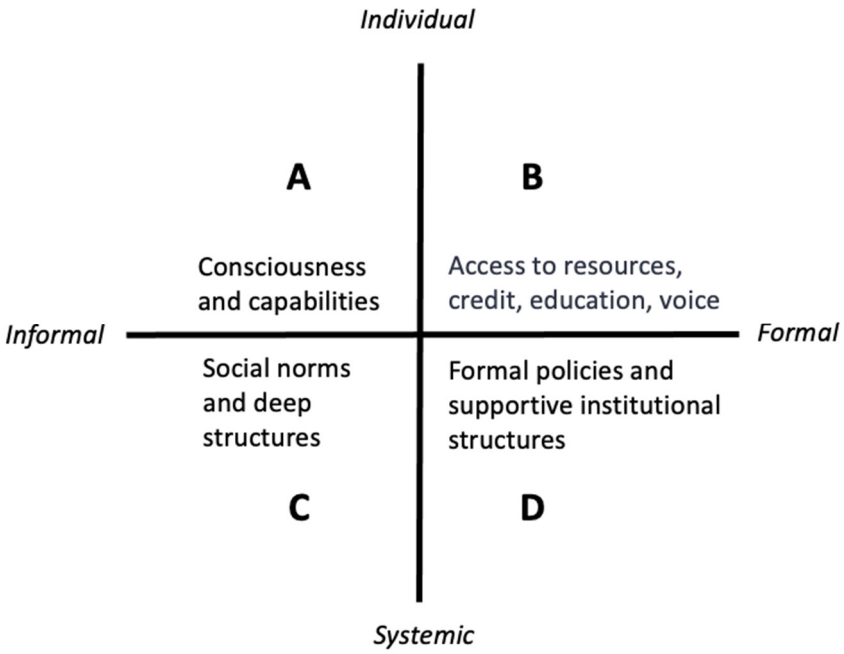

Figure 1. Gender at work analytical framework [45].

The right side of the framework refers to measurable and tangible efforts, while the left refers to changes that are hidden, invisible, or have fewer observable causes and effects. The x-axis represents informal and formal domains, while the y-axis refers to the individual and systemic domains. The framework will be used in the Discussion section to link ideas from agroecology and gender studies to analyse which combination of factors contributed to empowerment and where further change is needed.

2.3. Case Study Location and Context

Himachal Pradesh, the case study location, is one of the northern states across the Himalayan mountains. Agriculture is the source of livelihood for 71% of the population, and 78% of the total cultivated area in the state is rainfed [46]. It is a major producer of fruits and vegetables and is called "the apple state" of India. However, intensive agriculture has increased susceptibility to insects, pests, diseases, falling yields, and soil degradation in recent years [2]. About 90% of all farms are small, with less than 2 ha, or marginal, with less than 1 ha of land. The average size holding is 0.4 ha [47]. Land ownership amongst farmers is widespread on account of land distribution reforms; all farming households interviewed owned land. A few farmers had increased their holdings by leasing additional land. Traditional practices based on manure persist on many marginal farms, where agrochemical use is limited to pesticides. However, farmers who specialise in apples and high-value vegetables use a range of agrochemicals. It was observed that a diverse variety of crops were grown on each farm, including cereals, beans/pulses, oilseeds, and between fifteen and twenty-five vegetables and fruits.

Himachal Pradesh has the highest percentage of Hindu population in India, with 95.17% being Hindu compared to a national average of 79.8% [47]. The Scheduled Castes (SC) constitute 25.22%, Other Backward Classes (OBC) form 13.52%, and Scheduled Tribes (ST) form 5.71% of the population. ST are concentrated in three northern high-altitude districts, which were not included in this research. Historically, these communities have suffered discrimination from other castes.

The state is proud of its development indicators and its relative progress compared to other states in India. With a per capita income higher than the national average, the state is one of the wealthiest in the country. Income sources have emerged from agriculture, tourism, and hydropower. Moreover, the state boasts a high literacy rate, which places it among the top four states in India [48]. Dreze [49] described the literacy rate relative

to the other Indian states as spectacular. The state government has been committed to promoting girls' education with special incentives. With many villages having an active *mahila mandal* (women's group) in addition to the standard *gram panchayat* (village council), public action at the village level has been less male-dominated [50]. There is a high level of female labour-force participation, and women's involvement in economic activities outside the household is much higher than elsewhere in north India. Additionally, the 7% gender wage gap in 2017–18 compared to other states in India was the lowest [1]. However, much of the arable land is being used for developmental projects and industries. It leads to the erosion of local subcultures and women's livelihoods based on traditional agriculture [51].

Despite educational advances, patriarchal and patrilineal norms continue to take precedence over legal norms in land ownership. Although the Hindu Succession Amendment Act 2005 gives all Hindu women (married and unmarried) equal rights with men for the ownership and inheritance of property, substantial inequalities persist [52]. Women in Himachal Pradesh forgo their claim to ancestral property to maintain good relations with their brothers. Similarly, in their married homes, the land is inherited by their husbands, and should the husband die young, the father-in-law will not bequeath the son's portion to the daughter-in-law. Instead, the land will be inherited by other male members of the family. These ingrained beliefs and the norms for gender roles together form a profound cultural basis for gender inequality. No operational holdings in Himachal Pradesh are jointly owned. Women own 7.3% of operational holdings in comparison to a national average of 14% [47].

3. Materials and Methods

3.1. Methodology

This paper is based on qualitative data gathered over three visits to Himachal Pradesh, India, between November 2021 and December 2022. The study employed a gender-specific approach to gather women's perspectives of how NF transitions had affected them personally, and whether they had increased spaces for decision making, developed capabilities, and autonomy.

Data was collected in an iterative process that was split into two phases (Figure 2). Phase 1 consisted of focus groups in nine villages across three districts—Mandi, Shimla, and Solan—selected by extension officers based on the length of time the farmers had practised NF. The focus groups comprised women who engaged in a participatory force-field activity, ranking the challenges and benefits of adopting natural farming. The first phase provided insights into issues that required investigation, just as would be expected from a pilot study. It became clear that the women belonged to four types of farming households in relation to work burdens. These were (1) women-headed households (where a woman was single or widowed), (2) women cultivators with male-out migration (men worked in other towns or states and visited home periodically, e.g., every three to six months), (3) women cultivators where husbands mostly lived at home but held non-farm jobs, and (4) both women and men cultivated the land together.

In the second phase, purposive sampling was adopted that took the four types of households into account, in addition to caste; length of time that NF was practised, i.e., for more than two years; different agro-climatic zones, and types of crops grown. Districts and villages were selected to cover three out of four agroclimatic zones where farms predominantly grew either cereals or vegetables and fruits as cash crops. Overall, thirty-five villages were visited across five districts—Shimla, Solan, Mandi, Kangra, and Kullu. Phase 2 included five homestays with farmers. Homestays were useful for ethnographic research, helping understand women's work burdens, meeting their families, and generating rich accounts of their lives. Individual male farmers and farming couples were also interviewed to determine how decision making and work burdens were shared. Furthermore, program officials (7), extension services staff (22), civil society organisations (CSO) staff (5), and agricultural scientists (4) were interviewed to understand the context, challenges, objectives, and mechanisms being employed to engage with farmers and scale out NF practices. Each

visit involved repeat interviews with program officials and meeting different field staff through snowball sampling. Meetings with farmers were organised by extension staff and three CSOs based on purposive sampling.

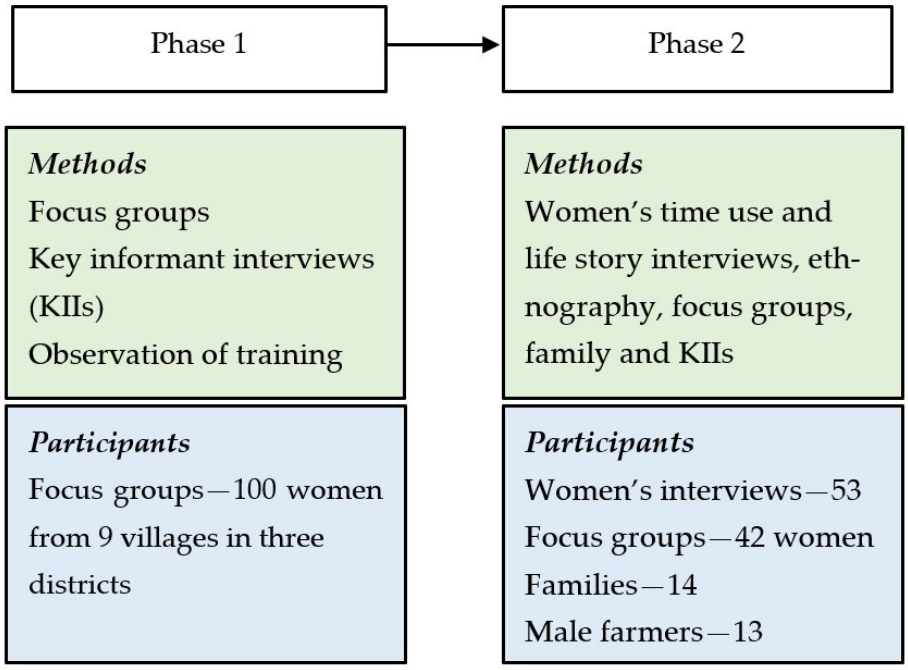

Figure 2. Phases of research and methods used.

Phase 2 included life story interviews (20), time-use mapping (26), and semi-structured interviews with women farmers, individually or in small groups of up to five women. The semi-structured interviews comprised two sets of questions. One set aimed to discover the NF practices adopted, the mechanisms used, the challenges encountered, the crops grown, and the results achieved. Another set of questions asked farmers how the NF transition processes had affected their lives in specific domains. The themes of domain-specific indicators of empowerment were derived from literature [38,53,54]. These included (1) leadership in the community, (2) control over decisions about agricultural production, (3) increased economic opportunities and control over income, and (4) effect on workloads. Within these domains, indicators for developing different powers—power within, power with, power to, and power for, or resisting power over—were noted. The interview template was developed through an iterative process, where additional contextual issues were identified as the research progressed. For instance, the first homestay with a farmer revealed how arduous collecting fodder could be for women, and related questions were subsequently included.

The first author conducted the interviews in Hindi, a language spoken throughout Himachal Pradesh. The transcriptions were coded using Nvivo to organise, analyse, and highlight the trends and nuances in the results. A quantitative approach was not used to summarise the results related to women's experiences, as these would fail to capture the nuances of local contexts and intra-household dynamics [55]. Instead, woman's accounts were used to describe their perceptions and the complex realities of their lives. Since introductions through extension staff could inhibit responses, it was clarified that the researcher was investigating improvements that were needed in the state scheme.

3.2. The Natural Farming Programme in Himachal Pradesh

To overcome the difficulties of CF, an organic farming policy was established in Himachal Pradesh in 2002. However, organic farming with purchased inputs was costly for farmers, and lower yields led to financial losses. In its place, in 2018, a State Project

Implementing Unit was set up to launch NF as a programme called *Prakritik Kheti Kisan Khushal Yojana* (PK3Y) (Figure 3) based on practices popularised by a farmer promoter, Subash Palekar. The main objectives were to reduce the cost of cultivation; increase farmer incomes, particularly for small and marginal farmers; grow healthy food; build climate resilience, and improve soil fertility and water-holding capacity. Its vision was presented in line with the FAO concept of sustainable food systems, which recommends holistic growth inclusive of gender, indigenous people, traditional cultures, health, and nutrition [56]. The state had 961,000 farmers, of whom 150,000 farmers, i.e., 16%, were reported to be transitioning to NF by the end of 2022. However, NF was practised only on 2.5% [57] of the net sown area, indicating farmers with very small plots of land featuring among NF farmers. Data on how many farmers were using NF on most of their holdings was in the process of being collected.

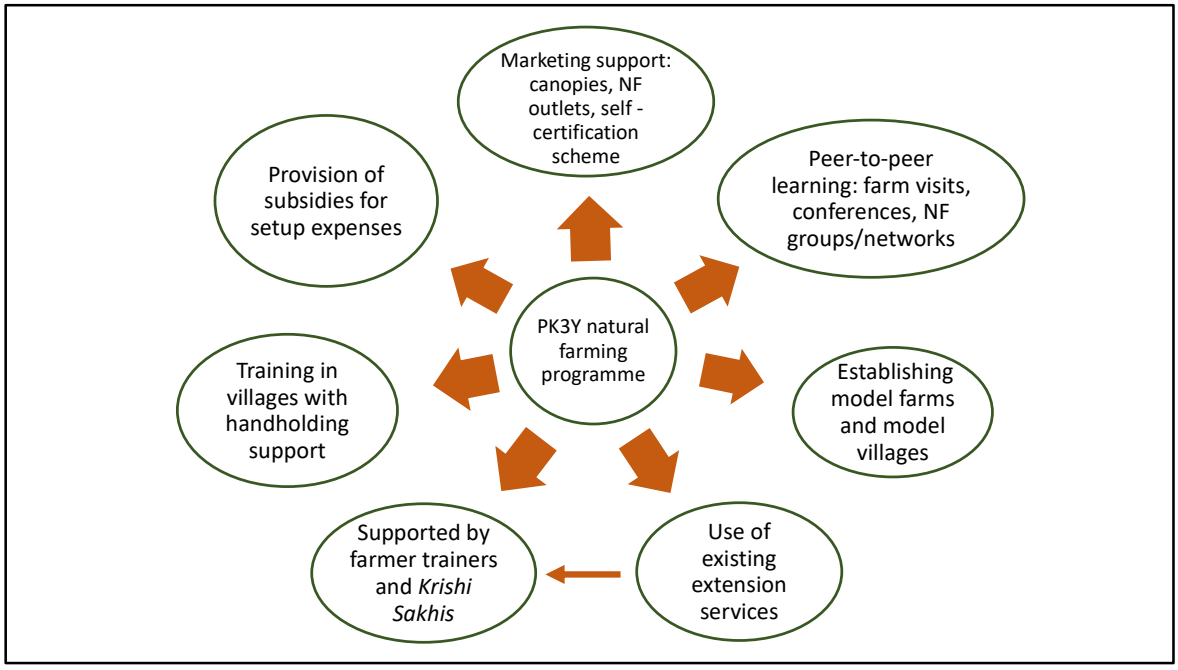

Figure 3. Key aspects of the PK3Y programme (based upon research interviews).

Palekar's methods were based on four essential practices aimed at regenerating the soil microbiome, for which an indigenous cow was recommended:

1. *Beejamrit*, a seed coating of cow dung, cow urine, lime, and soil to protect seeds from fungal or soil-borne diseases.
2. *Jeevamrit*, a fermented mixture of cow dung and urine, pulse flour, jaggery, uncontaminated soil, and water, acts as a microbial culture to promote microbial activity in the soil and enhance fertility. The microbes make soil nutrients bio-available to plants. The microbial culture is also used in its solid form known as *ghanjeevamrit*.
3. *Aachhadan*, mulching to conserve soil moisture and stabilise soil temperatures.
4. *Whapasa*, the maintenance of aeration and moisture in the soil through humus and limited irrigation.

Other practices include multi-cropping, intercropping and line sowing. Various concoctions with botanical extracts, sour buttermilk, and cow urine control pests and fungal diseases. The state offered subsidies for drums (up to three drums per family), cement lining for cowsheds, 50% for the cost of an indigenous cow limited to Rs 25,000 with Rs 5000 for transportation, and Rs 10,000 for a bio-resource centre (BRC).

PK3Y used the existing extension system, the Agricultural Technology Management Agency (ATMA), which had previously offered training in organic and CF. ATMA field officers, 37% of whom were female, were known as Block Technology Managers (BTM)

and Assistant Technology Managers (ATM), respectively. A BTM was required to have a master's degree, while an ATM was at least a graduate in agricultural sciences. In 2018 and 2019, the extension staff attended six-day training from Subhash Palekar and were reorganised at higher salaries to deliver the NF extension services. These training camps were also attended by progressive farmers. Each of the 80 blocks in 12 districts was assigned one BTM and two ATMs. Consequently, each BTM or ATM was responsible for extension to approximately one hundred villages. This number presented greater challenges in high-altitude districts relative to low-altitude districts. They had the added responsibility of informing and assisting farmers in accessing other government initiatives and schemes. The emphasis was on communicating the new techniques in a friendly and practical manner through demonstrations and working with the farmers in the fields. The training was also cascaded to the farmers via other farmers nominated as Master Trainers (MT) and *Krishi Sakhis*, community resource persons funded by a central government scheme. Although trained by Palekar, the extension staff were initially unsure whether the practices would work. Sometimes, they needed time to adjust recipes to local conditions to maintain yield. Essentially, they were learning together with farmers.

4. Results

This section begins with reporting the results related to the NF practices. Next, the processes or mechanisms used to support women's access to resources and learning opportunities will be explored to reveal how these opened pathways for women to build capabilities, skills, knowledge, and opportunities for collaborative work. Finally, results relating to changes in different domains of women's lives are recounted.

The following results refer to all farmers from Phase 1 and 2. All farmers who had practised NF for over a year reported that the soil texture had improved, and the population of earthworms had increased. The soil was crumblier or softer, and therefore, easier to till and weed. This concurs with findings in Andhra Pradesh [58]. Of the sample farmers, 60% of the farmers reported that the results in the first year had been poor for productivity and size of vegetables, e.g., cauliflower heads were smaller. From the second year of transition, 80% of the farmers began to notice that the yield was at the same or higher levels than previously. The crops were more climate resilient; wheat and maize had stronger stalks and did not lodge in strong winds or heavy rains. All farmers in the second year of practising NF reported increased shelf life, improved taste and appearance, and prolonged fruiting period for their produce. These factors contributed to increased income and diet diversity. Higher yields motivated farmers to plant more fruit trees and crops. Many farmers related stories about how their health had improved with NF. Women had reported experiencing skin rashes, headaches, body aches, and burning skin and eyes due to applying pesticides and chemical fertilisers. Three farmers, whose health had been adversely affected by CF to the point that they could no longer work, said they regained their health with NF.

4.1. State Mechanisms to Facilitate Uptake of Natural Farming

4.1.1. Face-to-Face Farmer Training

The BTMs and ATMs delivered training in the villages themselves, rather than setting up a camp in a block or agricultural institutions that the villagers would have to travel to. This increased access to training, and women could participate with ease. In many villages, it was the first instance of agricultural training that they had ever attended. Women from a SC village said:

"People like us did not get trained or find out about training or attend any."

The trainings were arranged either through existing women's self-help groups (SHGs) if these had been previously established by ATMA, or through a known farmer or through a *panchayat* (village council). Training dates were selected by consulting the farmers. Farmers were first encouraged to try NF on a part of their farms, particularly in kitchen gardens. In districts where male outmigration was prevalent, or men held local jobs, primarily

women attended the training. Statewide, about 60% of the trained farmers were women. A village training lasted two days with lunch provided and comprised a mix of theory and practical demonstrations. It was delivered jointly by extension staff, a progressive farmer, or a farmer who had attended the Palekar training camps and was nominated as an MT. The involvement of a local farmer in trainings was believed to lend greater credibility to practices being promoted. The MTs were familiar with local crops and growing conditions and could communicate in local dialects. It was observed that women listened to a woman MT with greater attention when she spoke in the local dialect.

At the outset, the person trained became both the advocate for and the expert in NF in the family. The trained farmer, whether a man or a woman, was the one who made the NF formulations and developed an understanding of what adaptations were required, what worked, and what did not. Adapting the formulations to local conditions requires creative thinking, intuition, and experimentation. Rather than merely indicating who bore the burden of extra work, the NF training engaged women in new endeavours and facilitated decision making and problem solving. It challenged cultural gender norms, as highlighted by a male farmer:

> *"According to the local culture, it is men who attend trainings and meetings, and the men also take the decisions."*

As NF methods offer a range of safe ingredients and equipment mostly available on the farm, they facilitate experimentation. In many villages visited, there was evidence that women were testing and adjusting the NF preparations to find the best combination to overcome challenges, such as pest attacks. In one village, a woman farmer first experimented with different quantities of *jeevamrit* to investigate its effect on the growth of young apple trees. She subsequently altered the recipes to suit her context. One farmer compared the effectiveness of different pest control substances, including chemical pesticides, cow urine, and NF concoctions, and invented combinations, such as tobacco leaves mixed with cow urine. In another village, a group of women altered the frequency of application and recipe of a mixture of sour buttermilk and *jeevamrit* to deter animal raids. They tested it further in areas where wild pig raids were occurring to check its efficacy and were encouraged by the BTM to share their innovations in training sessions. Through their agency and critical thinking, the women invented a practice to save their crops and increased their productivity by a third.

4.1.2. Establishing NF Groups and Networks

Along with the training, the extension officers formed an NF group of up to 25 members; therefore, a village of about 50 households would have two NF groups. Previously existing SHGs were used in some villages. They became the channel for communication from the extension staff and the means for handholding—some extension staff made the solutions together with the women during their monthly meetings.

There were several benefits to forming NF groups. They comprised members from similar socioeconomic backgrounds and became a mutually supportive learning community through their regular meetings and the use of social media, usually WhatsApp. In some villages with no previous SHGs, the NF groups were the first to offer collaborative spaces for speaking and discussing common concerns. These developed capacities to talk, think through issues and find solutions to challenges. As a result, they became hubs for social, learning, and economic activities. In villages where farms were distanced from others, the NF group meetings offered opportunities to meet regularly. In one such village, the women turned the monthly meetings into celebratory events with music, singing, and eating together. As a government initiative, NF offered women greater freedom to spend time away from home for training or meetings.

Moreover, the SHGs acted as saving groups, where each woman contributed a small amount a month to a savings account that members could borrow from at a low-interest rate. The funds became a handy source of credit for women. They also used their savings to build community resources, such as purchasing mattresses and folding chairs for events and

family gatherings. Working collaboratively generated income opportunities, such as selling homemade food products at community fairs and NF events. During the COVID lockdown, members of a group cooked sweets for Diwali to share and sell in a farmer's market.

Establishing NF groups strengthened the traditional culture of reciprocity and labour sharing in Himachal Pradesh, known as the *jowari* system. *Jowari* is an informal institution where village members contribute their labour and time in a free exchange system and for managing common village property resources [59]. Western sociologists refer to this as a dimension of social capital. Putnam [60] (p. 19) defines "*social capital*" as "connections among individuals—social networks and the norms of trustworthiness and reciprocity that arise from them". Women in several villages reported working in groups to help each other with farming tasks during busy periods. When NF practices were introduced, women worked collectively to sow in rows, which is more labour intensive than broadcast sowing. Women groups made the NF preparations in the initial stages of implementing NF in all the villages visited, and some groups continued to share the tasks. The labour-sharing culture helped mitigate the burdens in marginal farms where the men held non-farm jobs.

Collective work and reciprocity engendered through the NF groups reinforced social cohesion and social capital. Not all exchanges in villages were monetised, thus representing use value rather than exchange value. These involved sharing labour, seeds, crops, and resources for NF formulations. Giraldo and Rosset [61] describe exchanges of use value as fundamental to transformative agroecologies, as these consolidate solidarity and cooperative economies. The farmers could access most materials within the village itself free of cost. Farmers who owned indigenous cows made the cow dung and urine available to others. However, transporting the materials to their farms was often laborious and viewed as an extra burden that some women preferred to avoid undertaking. Therefore, not owning a local breed of cow became an obstacle to adopting NF. The advice to farmers was altered later to increase the proportion of cow urine from non-indigenous cows in recipes so that farmers could use their own crossbred Jersey and Holstein cows.

The social networks became a pathway for informal and horizontal farmer knowledge exchange. Using a messaging app on smartphones became a vital tool for dialogues of knowledge and learning [61]. Farmers posted pictures, appreciated each other's work, and raised questions on how to manage diseases. Moreover, two-way interchanges between farmers and extension staff took place: the extension officers informed members about techniques, success stories, which farmers had indigenous seeds to share, and forthcoming meetings, while the farmers contacted them with any queries regarding practices. A messaging app, therefore, became an essential tool for handholding. A BTM posted videos of farmers, often women, explaining various practices. These demonstrated to women that they were valued and promoted enthusiasm and motivation. In addition to the village NF groups, there were block- and district-level WhatsApp groups, which included extension staff and both male and women farmers. MTs became members of a state MT group. The wider groups enabled communications about farmer innovations and became an indigenous seed exchange mechanism. However, communications about farmer-led innovations did not seem to be communicated between districts; for example, extension staff in various districts were unaware of how the NF solutions were being used to deter animal raids by farmers in Solan district.

4.1.3. Visits to Farms and Conferences

Another mechanism critical for the horizontal transmission of knowledge used by PK3Y, in alignment with agroecology principle 8—co-creation of knowledge—was for farmers to visit progressive or model farms [25]. Extension staff organised visits to model farms established in each block or to those in other states. Additionally, there were state-level women's farmers meetings held on occasion. PK3Y arranged for 721 women farmers to attend a two-day conference in 2022 to mark International Women's Day. It is widely acknowledged that horizontal exchanges were vital to the success of the agroecology movement in Cuba, the most successful worldwide, which grew to over 100,000 smallholders

in eight years. A study of the campesino-a-campesino (farmer-to-farmer) methodology revealed that training workshops were followed by farmer gatherings and conferences where one group of farmers visited another to see sustainable practices at work—tools, seeds, information, and knowledge passed hand to hand as an example of shared cultural praxis [62,63]. In Himachal Pradesh, visiting other farms inspired farmers to try the practices. After seeing the crops grown by other farmers, women began to grow a wider range of crops, which positively impacted their dietary diversity. For some women, the visits were a significant event in their lives and the first opportunity they had had to travel out of their district or state, as illustrated in Vignette 1:

Vignette 1.

LK, a 35-year-old farmer practising NF for four years, suffered from PTSD because of traumatic events in her childhood. Her father died when she was six years old. Her mother worked hard to raise three children with no support from her community, as widows faced discrimination. Tragically, their home was washed away in a flood, after which they lived in a small wooden hut. LK married at age 21 and cared for her two children, their 0.8 ha of land, and two cows, mostly on her own since her husband had a job. She reported that whereas previously she used to get anxiety attacks, these had not occurred since she began practising NF. The practices kept her happy and busy. She enjoyed making the solutions and checking the crops for problems, which she resolved with support from the extension agent. The only break she had ever had from her 14-h-long workdays was when she participated in an out-of-state NF trip for three days.

4.1.4. Leadership in the Community

Women who held leadership roles as MTs benefited greatly. An MT was responsible for delivering training to villages in three *panchayats* with extension staff or on their own. Seventeen MTs who were interviewed agreed that the leadership roles had been beneficial in building their confidence, widening their social network, and earning respect from the community. They appreciated the support they received from extension staff to develop confidence in addressing groups. The role gave them freedom of movement, overcoming cultural restrictions on their mobility in public spaces. In the more populous districts, women felt safe travelling to villages independently. Three MTs commented on how it improved their learning as they aspired to become more knowledgeable. A 40-year-old farmer commented on how social interchanges affected her well-being:

> *"When you leave the home, meet people and socialise, it freshens your mind and brings about change. When the mind is at peace, the person is happy. Peace of mind also affects your body. If a woman is not healthy, how can she raise healthy children or a healthy family."*

Once they became known in the community, it created a domino effect for their involvement in community projects. One MT was selected as the secretary of an SHG federation comprising 150 members; another was chosen as the chairperson of a Farmer Producer Company facilitated by PK3Y. In an SC village, the MT and women from the NF group volunteered to run a state programme to teach basic literacy skills. They gave daily lessons for three months to women who had missed out on an education. For a few women, it became a catalyst to realise long-held personal goals; e.g., an MT chose to complete higher secondary school. Another farmer added an outside room to set up a shop in her house, which had been a long-held aspiration. The transformations in personal power triggered a shift in power relations within the home and the community. LK spoke about how her increasing confidence had resulted in altering intra-household relations:

> *"I used to feel that I had only studied till the 10th and I didn't know anything. I used to be afraid. Now, I have learned how to speak to people with confidence, and my knowledge has increased. My husband has noticed the change in me and looks to me to make decisions. It is because of NF that I am recognised; I have progressed and moved up in life."*

4.2. Autonomy in Decisions about Agricultural Production

In areas where there was high male outmigration from marginal farms, such as in the Mandi and Kangra districts, women farmers had greater autonomy in decision making with respect to agricultural production and farm incomes. This was particularly evident where farm incomes were supplementary to the main sources of income. Although all the women reported that they discussed major decisions with their husbands, this did not detract from their autonomy; rather, the decision making was part of an ongoing cooperative household dynamic. When the women informed or consulted their husbands of their decision to use NF methods, the husbands were supportive.

In contrast, where men farmed full-time and grew cash crops, such as apple farmers in Kullu district, customary division of gender roles tended to persist, wherein men were the decision makers. This hindered the transition efforts made by women. Women began to use NF in kitchen gardens, while men continued the use of CF in apple orchards. Some women negotiated with their husbands and in-laws to try out NF in plots other than kitchen gardens. Three women mentioned that they were only allowed to practise on small plots of degraded land that had been left fallow. While they trialled NF, they endured ridicule and criticism, often lasting longer than a year till a good harvest was achieved. Many women, therefore, were taking the lead in scaling out efforts, despite facing significant challenges and pressure. In a few instances where household relations were more equitable, women persuaded their husbands to adopt NF and share the decision making. A male apple farmer in Kullu reported:

> *"It was my wife who was trained first. She discussed it with me. I said I was aware of the issues with chemical farming and suggested she try out the alternative practices. Now we have expanded the area under NF; we discuss what needs to be done next and make joint decisions."*

4.3. Increased Economic Opportunities and Control over Income

About 25% of farmers interviewed were able to increase their income by selling NF produce directly to the public. This was often the case in Kangra, a populous district with many non-farming families. Some farmers developed a network of buyers who would place orders in advance and collect from the farmer. These sales secured between 10% to 20% more than the market rate on account of crop quality and their NF status. Marginal farmers with small holdings benefitted from selling their crops through the outlets arranged by PK3Y. This comprised NF canopies managed by farmers and set up at central locations on particular days of the week. Some farmers used their own or group canopies to sell at community events or in their villages, as illustrated in Vignette 2. Increased incomes through NF resulted in the women contributing more to household expenses, which altered their status within the home. Women proudly stated how their earnings contributed to the extension of their home or the everyday household expenses, or paying for their children's education.

Vignette 2.

RK, a 32-year-old farmer from the OBC caste category, lives with her two children, her husband (a schoolteacher), and his parents. She farms 0.75 acres of land (0.3 ha). Her in-laws opposed natural farming, particularly as the result in the first year was poor. However, RK persisted as she wanted to save costs, care for the soil, and eat healthy food. Despite family opposition, she borrowed Rs 80,000 from her SHG and travelled out of state alone to buy the highly prized *Sahiwal* cow for Rs 65,000. She received a subsidy for Rs 30,000 towards costs and paid back the loan through sales from her bio-resource centre and selling milk and ghee. The crop yield improved in the second year, and RK began to grow a wider variety of indigenous cereals and vegetables using seeds she sourced through her farmer networks. Her farm provided for all household foods and a diverse diet. RK sold vegetables in the village green about three times a week using the NF canopy given to her by PK3Y. Her income doubled within two years of starting NF, and she is now establishing a business to sell pickles jointly with her husband.

Farmers who had previously practised organic farming found that purchased biological inputs were expensive and did not increase yield. They reported that switching

to NF significantly increased their income. For farmers transitioning from CF, savings on costs of chemical inputs depended on the types of crops grown. Savings for farmers growing disease-prone cash crops, such as capsicums and tomatoes, where chemical inputs cost around Rs. 100,000 per acre annually, were substantial. Costs were reduced by 90%, resulting in a 30% increase in annual profits. Additionally, for all farmers, several factors, such as farming the plots more intensively with a wider variety of crops, a higher yield, a more extended fruiting period, longer shelf-life, and better appearance, resulted in higher incomes. Encouraged by PK3Y staff, farmers began growing more indigenous cereals, such as red rice and millets, for consumption and higher selling prices. Many of these factors also contributed to their diet diversity. Most farmers were hopeful that being certified as NF farmers under the new Certified Evaluation Tool for Agriculture Resource Analysis (CETARA) system established by PK3Y would secure higher prices for their produce [64].

Establishing a bio-resource centre (BRC) was seen as a profitable opportunity for women farmers, as they reported earning between Rs 1000 and Rs 5000 per month, depending on the demand for NF formulations in their village. However, a woman farmer discovered that replacing her two Jersey cows with two *Sahiwal* cows (an indigenous breed) to set up a BRC resulted in a loss of income. The *Sahiwal* cows, purchased from a neighbouring state, did not adapt well to the colder climate in Himachal Pradesh, resulting in a loss from milk sales. Furthermore, the sales of cow urine and NF formulations were insufficient to compensate for the losses.

Most women interviewed had an independent source of income other than crops and the husband's earnings being shared with the wife for household expenses. Usually, this was derived from selling milk and food products or sewing and handicrafts. On farms where the husband sold farm produce in the *Mandi* (wholesale market), the cheque would be deposited in the husband's account to be shared later with the wife. In some households, cash payments from the *Mandi* would be transferred to the wife. Many women felt it was essential to have their own earnings allowing them to spend money without having to justify expenditure either to themselves or their husbands. This was especially relevant for a few women who had toiled hard over the years and had been denied their share of income from the farm. Where gender relations were mutually supportive, some women did not think they needed an income that was theirs alone.

4.4. Effect on Workloads

A time-use survey with 26 women farmers revealed that the average workday comprising both care and productive work, excluding times for personal care and leisure, was fourteen hours long. It started early, often at 5.00 a.m., for women to first attend to their cows (or other livestock). All women farmers interviewed, except for two women, owned cattle, commonly one or two cows. Livestock care was time-consuming. Collecting fodder took two hours a day on average and could be excessively burdensome and risky. It involved women carrying 30 to 50 kg loads on their backs or heads over long distances or steep terrain in high-altitude districts. Many women also climbed trees to cut branches. On days when the women worked as waged labourers for a Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA) project, they started the day at 4 a.m. to allow for fodder collection. In Mandi and Kullu, the women spent several weeks in Autumn gathering stocks of dry grass and firewood two or three times daily to store for the snow-bound winter months. A round trip from the forest could take several hours. During this period, men also helped carry loads. Farming in the fields typically took three hours a day, with seasonal variations, to cultivate one acre (0.4 ha) of land.

Another arduous task related to livestock that women performed daily was carrying cow dung to the fields to add to a farm yard manure (FYM) heap. NF practices offered an alternative which eased this burden. If FYM was applied directly, 80 kg of cow dung was required for 40 fruit trees. NF offered the alternative of replacing FYM with one drum of *jeevamrit* that needed only 10 kg of cow dung. However, most farmers interviewed strongly felt that using FYM was a traditional practice they would not relinquish. In contrast, a

woman from a mountainous district felt that NF had relieved her of the burden of carrying cow dung uphill daily to the field. Instead, she needed to carry 50 kg *ghanjeevamrit* for her 1 acre (0.4 ha) plot four times a year.

Women who made their own formulations reported that the tasks added two hours a week to their workload. They found that this was a fair trade-off for saving costs. When both the husband and wife had received training, the tasks were shared. Farmers said that the spraying schedule was equivalent to that of conventional farming. This varied, however, according to the crops grown and seeds used. Farmers growing tomatoes from hybrid seeds needed to spray pest-control or anti-fungal concoctions twice a week, which added to workloads considerably. The burdens were mitigated by sharing the spraying tasks with the family, including older teenage children who had previously not been allowed to spray chemical pesticides. Farmers with larger plots reported that line sowing, applying mulches, and weeding by hand added to workloads or labour costs.

4.5. Perceived Constraints on the Adoption of Natural Farming

The NF interventions were taking place in the context of constraints. Sen [42] refers to these as "conversion factors" which can block or differentiate people's ability to acquire capabilities and achieve goals. These contextual conversion factors may include family characteristics or physical and socio-economic constraints. They could impede the take-up of NF or its scaling out; for example, horizontal exchanges were constrained by the unavailability of smartphones for some women—those women who started with better assets and capabilities captured more significant benefits than those who did not.

The most immediate challenges to farming were lack of rain and animal or stray cattle raids. Several rainfed villages had no rainwater harvesting structures or watershed development. In villages where animal raids were causing extensive crop damage, the women did not know any NF recipes to deter animals. Often they were not aware of subsidised solar fencing schemes or the options available. Women felt it was pointless taking up NF, as drought and animal raids would hamper their efforts. Family opposition was another constraining factor. However, a few women adopted NF despite experiencing ridicule and hostility from older family members, often fathers-in-law, which continued till good results were achieved. All male farmers felt that being able to sell their NF produce at a higher price would accelerate out-scaling.

Some women rejected NF as it appeared complicated, or because they felt it would increase their workloads to an intolerable level; for example, mothers with young children, women farming on fragmented and distant fields, or those without help at home or with many animals. Lack of support in the home or from the community when the plots were larger or where the fields were at a distance made for greater work burdens.

Inadequate planning and execution by a state department can hinder the adoption of NF. Even the most well-intentioned project can be negatively impacted by staff members who hold opposing views or lack personal engagement and skills. For instance, extension staff provided varying levels of handholding support, and exposure visits to model farms were infrequent. Additionally, a few extension officers failed to inform women about government schemes that could help mitigate challenges or offer appropriate support in acquiring subsidies. Although indigenous seeds were promoted, some officers with an industrial agriculture mindset distributed hybrid seeds to farmers. This raises the question of how managers and front-line workers can be empowered to act as agents of change.

Lack of land ownership is a further perceived constraint for women. A woman farmer reported how she failed to secure a bank loan to start a ghee-making enterprise because she did not own land. The lack of access to credit limits women's freedom of action and choice and the means to improve their economic status, and circumvents their creative and productive potential. In a domestic situation, economic abuse is recognised as preventing a cohabitant from acquiring resources or assets or advancing their careers, or restricting their ability to find employment. An individual uses this abuse to exert power and control over another. It may be argued that societal norms of denying land to women are an expression

of economic abuse perpetrated collectively on women. In Himachal Pradesh, it is disguised as a cultural tradition that encourages good sibling relations.

Every woman interviewed who had siblings had agreed to gift their portion of land to their brother/s, or in one instance, to a sister who was caring for the parents. They had either made the decision when their father asked if they wished to inherit a portion of the land, or after his death at a meeting held by the land inheritance official. The officials often pressured the daughters to relinquish their share in favour of their brother/s [52]. A male farmer remarked that a woman's failure to gift the land to her brothers was considered lowly and dishonourable. A woman who had one sister and two brothers said:

> *"My father willed the land to the sons so that we would not need to attend a meeting with the tehsildar to give up our portions. This is an old tradition. In case there is a problem where the sister's marriage fails, the brother will give land to the sister for her to build a home. We trust the brother."*

However, SK, an MT and divorced single woman living with her parents and brother for twelve years since her divorce, had yet to receive land or the promise of land from her parents. SK actively supported single women to take up NF:

> *"For a single woman, it has had many benefits. There are some who were widowed early. Rather than thinking about issues at home and feeling depressed, they get out of the home, meet people and get busy with a project."*

Despite her leadership capabilities, she did not question the validity of the patrilineal norms and felt that asking for her portion of the land would reflect poorly on her.

5. Discussion

When implemented with adequate mechanisms for training and supporting women farmers, the NF initiative was seen to reap a range of benefits. The mechanisms described in the results above have been organised using the gender at work framework (introduced in Section 2.2) in Figure 4 below. How the individual and systemic changes impacted women will be discussed next.

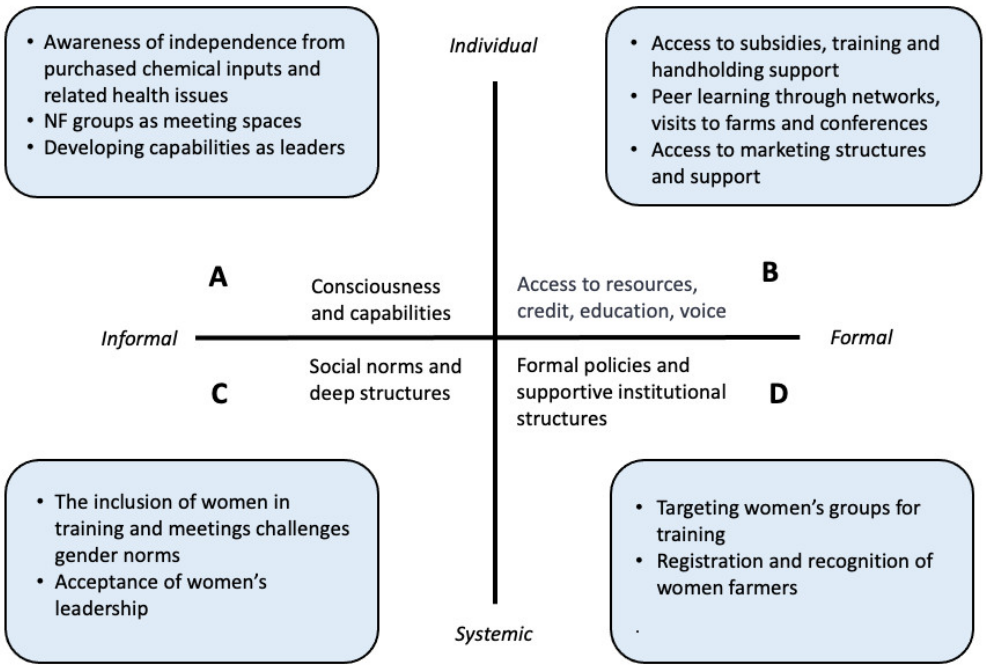

Figure 4. Gender at work framework [45] with added summaries of state mechanisms and their effects in the blue boxes.

First and foremost, as a counter-movement to industrial agriculture, NF opened pathways to restore food sovereignty. A shift to industrial agriculture had alienated women from their traditional farming knowledge and marginalised their roles. In contrast, the NF programme raised women's awareness of their capacity to make decisions and become independent from corporate control (Quadrant A). Women recognised the independence, dignity, and control that NF gave them:

> *"I learnt that we have the ability and resources to make whatever we need. We do not have to depend on the market. Knowing that I can rely on myself makes me feel confident."*

Further, a new vision of creating an ecologically friendly way of farming for the greater good inspired and motivated both women and men farmers to persist with their efforts. The NF vision of caring for "mother" earth, one's health, and protecting the land for future generations resonated with women's spiritual values. Women viewed NF as a worthy cause that made farming more meaningful. The fact that people may act for the good of others is a vital part of Sen's capability approach [42]. It is broader than many concepts of agency because the agent is not self-centred:

> *"I feel good that the earth is safe, and we are not feeding poisons to people. I am establishing an example for future generations to follow."*

Some women chose to pursue goals for the greater good despite opposition from their families. A SC woman wanted to revive millets for the benefit of the village farmers. She reported:

> *"My husband tried to discourage me, but this made me even more intent on proceeding with the project. I argued that it would be beneficial for the women in the village and also to sell."*

Establishing NF groups (Quadrant A), brought women together to share experiences, reflect, and build solidarity towards a common cause. These enabled women to discover common ground by realising that their problems were similar to those experienced by other women. A new perception of reality was constructed. A 38-year-old SC women farmer explained how joining a group developed confidence and agency:

> *"When we work the whole day, we do not even realise how hard we have worked. When we join a group, we get a good opportunity to express our thoughts and discuss our issues. When we attend a meeting, we get to learn new things. By joining a group, we acquire confidence and the capability to act."*

In contrast to the industrial agriculture paradigm, which dispossessed farmers of their knowledge, a transition to agroecology is knowledge intensive. Maximising the ecological advantages of the local environment requires individual ingenuity, utilising traditional and new knowledge, creativity, and innovation [21,65]. The women appreciated how NF engaged their minds and expanded their knowledge:

> *"We find natural farming interesting, and it keeps our minds active. We want to learn more about how to control diseases."*

It was evident that in addition to peer-to-peer knowledge exchanges, there was a need for structured learning options that advanced knowledge beyond basic practices. A farmer who had undergone the two-day training explained:

> *"I am hesitant to advise other farmers. What if it affects them adversely? I have not been trained properly; I am just following what I have been told by ATMA staff."*

While there may be a need in the early stages of transition to introduce recipe options that produce quick results, the full benefits of a transition, such as increased production, fewer pest attacks, and reduced need for inputs, can only be realised upon greater agroecological integration [66]. These call for an understanding of how complex ecological processes interact. Given that many women do not have access to the internet through smartphones, the state needs to think about how access to learning networks and training

could be assured for them. The requirement for farmers running model farms, *Krishi Sakhis*, farmer trainers, and extension staff to be well-versed in a range of NF practices and the vision of NF as a new food systems approach becomes even more critical.

When women were trained and demonstrated an interest in NF, it became the starting point of a widening social network where increased interactions with farmers, extension, and government officers developed the "power with". It built capacities to talk to government employees, raise questions, and share knowledge with their peers. RD, a 40-year-old SC farmer, received visitors and visited other farms; she spoke at a *panchayat* (village council) meeting and a video of her explaining practices was posted on YouTube by the BTM. She explained how social interactions and recognition built her sense of self-worth, identity, and purpose, which developed her civic capacities and citizenship power:

> *"When we started natural farming and got good results, we began to be known by other people. People asked us about the practices and wanted to visit our farms. It made us feel happy and that we were significant and had a place in the world. . . . . We are learning more about government schemes by meeting people and attending panchayat meetings. We now support women by registering requests. We have gained the confidence to state our wants or speak about what is needed in the community."*

Transition mechanisms aligned with the principles of agroecology listed in Quadrants B and D created new possibilities for empowerment for women. NF became instrumental in developing the existing dynamism in women, building confidence and capabilities, which, for some, resulted in a gradual change in the power relations in the home and society. The fact that women attended training and had direct access to subsidies strengthened their roles. The CETARA system established by PK3Y formalised the recognition of women as farmers. These measures challenged notions of gender identities and exemplified how the state could influence people's capacities to think differently, and thereby construct a new "common sense" [67].

It was evident that despite women's developing capabilities and empowerment in the social domains, certain deep cultural norms that exerted "power over" women's choices remained unchallenged (Quadrant C). In particular contexts, empowerment in the social domain had yet to translate into increased autonomy in the domestic domain, and patriarchal norms impeded transition efforts. Changing deeply held norms is complex, and a variety of strategies are needed at the individual and policy levels to address gender disparities effectively [68]. Transition mechanisms and policies must be scrutinised for their differential impact on women, and all data must be monitored by gender to understand the specific gender imbalances in different locations and contexts. For example, when male farmers were dependent on income from cash crops, they were more risk-averse and unwilling to relinquish control over farming decisions. The mechanisms needed for Kullu district, where men are the primary decision-makers, differed from those required in districts with male out-migration. In such contexts, it is important to introduce both men and women to NF and emphasise the benefits of joint decision making. This could be facilitated by couples sharing their experiences of working collaboratively via videos, news channels or training.

Similarly, the state can take steps to change societal norms that prevent women from owning land. One way to encourage women's land ownership is to waive fees and offer incentives and recognition to male farmers who add their wives to land titles or fathers who bequeath land to their daughters. The argument that daughters do not inherit land because it causes further fragmentation should apply equally to male siblings. In practice, many rural families cultivate land jointly, including land belonging to siblings who may have migrated for work.

6. Conclusions

This research paper investigated how a state-led transition to natural farming, an agroecological approach, empowered women farmers. What this study interestingly showcases is that it can offer spaces into previously unimagined women's empowerment through

agroecology as a mechanism. A nuanced understanding of women's lives and choices exposed the power dynamics and how they manifested in the transition process. The positive collaborative spaces created by forming NF groups built the "power within" and "power with" and engendered a rich communication dynamic for learning and innovation. These new alliances for a common cause harnessed the "power for" and strengthened their resolve to traverse new territories and take greater risks to realise a vision, even when subjected to family censure. This was observed across castes. The increased capabilities developed through leadership roles, illustrative of the "power to", spurred the women to undertake further personal and community projects. At its most effective, the benefits derived from increased empowerment not only rippled out to the advantage of other women, communities, and initiatives but across generations, as in some instances, children of the women became involved with the NF work. In short, for many women, their growing sense of self-confidence and faith in their own developing capabilities contributed to "extending the horizons of possibility, of what people imagine themselves being able to be and do" [69] (p. 3).

The state's success in promoting natural farming depended significantly on the active participation of women in facilitating the transition processes, despite their already substantial workloads. So that the state does not burden women to contribute even greater efforts, often in adverse circumstances, women's efforts must be fully supported. In contexts where gender dynamics play an obstructive role in agroecology transitions and in restoring food sovereignty, the state needs to establish policies that challenge oppressive norms and enable women to exercise their right to make decisions about agricultural production. Consulting women is essential to understand their needs and preferences and to strengthen their capabilities and knowledge.

This case study illustrates how an agroecology transition with a deliberate gender equality perspective can significantly enhance life outcomes for women farmers owing to their increased sense of empowerment. Providing opportunities for decision making and reclaiming their food sovereignty can mobilise women to harness their strengths, talents, and creativity to bring about transformative change in their lives and communities. Further research is needed to explore how more women farmers can overcome obstacles and participate as decision makers and innovators in agroecology transformations.

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