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Climate Services 14 (2019) 1–14

Contents lists available at ScienceDirect

Climate Services

journal homepage: www.elsevier.com/locate/cliser

Original research article

An investigation of the effects of PICSA on smallholder farmers' decision-making and livelihoods when implemented at large scale – The case of Northern Ghana

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ARTICLE INFO

Keywords:
Climate variability
Climate change
Participatory approaches
Options by context
Smallholder farmers

ABSTRACT

Participatory Integrated Climate Services for Agriculture (PICSA) is an approach that has been used to date in 20 countries and benefited tens of thousands of households including over 5000 in Northern Ghana and 75,000 in Rwanda. PICSA involves trained field staff or community volunteers working with groups of farmers and includes farmers: using both historical climate information and forecasts; exploring practical options to address challenges and; using participatory decision making tools to evaluate and plan options for individual farm contexts. A survey of randomly selected farmers and detailed case studies was used in Northern Ghana to investigate the influence of PICSA on farmer's decision-making, livelihoods, and innovation behaviours. Ninety seven percent of farmers had made changes to their practices (mean of three per farmer), including starting new enterprises and a wide range of management practices. Farmers described positive effects including on income and food security and importantly on wellbeing, and confidence in their abilities to address climate change and variability. In case study interviews farmers clearly explained the rationale for their changes as well as reporting how they actively sought and obtained further technical information and resources. Innovation processes observed are in stark contrast to those associated with linear dissemination of technology models.

Practical implications

The Participatory Integrated Climate Services for Agriculture (PICSA) approach has been successfully used in at least 20 countries and benefited tens of thousands of farmers to date. This paper outlines how PICSA was implemented in Northern Ghana and investigates its influence on farmer's decision making, households and innovation behaviours, and the reasons behind its success.

The PICSA approach is implemented by trained intermediaries (extension workers, NGO field staff, community volunteers) through a series of training sessions with groups of farmers (usually around 3–4 sessions per group). Intermediaries are encouraged to work with existing farmer groups rather than setting up new structures for the training. Within these sessions, trained intermediaries facilitate farmers to complete the twelve PICSA steps (see Dorward et al., 2015).

Each of the PICSA steps contain a set of structured 'activities' or 'tools' which enable farmers to consider firstly their own context, their local climate and their options. The first Step (A) enables the individual farmer to consider their own context through compiling a Resource Allocation Map (RAM) and a seasonal calendar to clearly outline their current resources, the main activities they undertake on and away from the farm, their timing and how climate and weather affects those activities. Step B then introduces a set of locally specific climate graphs from the nearest available meteorological station which include information on season start and end dates; length of season; amount of rainfall in the season; frequency of damaging dry spells and other extreme events; and temperature. Farmers and intermediaries jointly analyse these data to consider trends and variability. Step C then trains farmers (irrespective of literacy levels) to calculate simple probabilities from the climate graphs so that they are better able to

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https://doi.org/10.1016/j.cliser.2019.02.002
Received 26 August 2018; Received in revised form 27 December 2018; Accepted 6 February 2019

consider opportunities and risks (e.g. the probability of an amount of rainfall in a given period, dates of onset of season *inter alia*). Steps D & E then move the discussion forward from opportunities and risks to consider specific options. An options matrix is used for farmers to firstly suggest and then quickly analyse and compare different crop, livestock and livelihood options that may help farmers in the context of their local climate and resources. Step F enables individual farmers to compare the different options and plan using Participatory Budgets (PBs). PBs enable a farmer to consider all of the inputs and outputs associated with an option and how this will pan out over a given time period (perhaps a number of weeks for a poultry enterprise, a season for a crop or a number of years for an agroforestry option). Step G is the point at which farmers start to firm up their plans for the season and it is important to note that as it is based upon historical climate information all of these steps happen long before the season. Steps H & I are then introduced 'just before the season' after the seasonal forecast or equivalent (in countries where it is available) has been released by the National Meteorological Service. Depending on the strength of the forecast and farmers individual contexts they may decide whether and how to adjust their plans in the lead up to the season. Steps J & K cover short-term forecasts (usually one, five or ten day forecasts) and how farmers might better use these forecasts to influence their activities within the season (e.g. might a forecast of heavy rain affect my plans to spray fertiliser today or might a forecast for a dry spell affect my decision to sow)? Step L then happens after the end of the season and is intended to encourage reflection and learning ahead of the next season.

As the results from the quantitative survey (n = 416) and farmer case studies (n = 18) make clear, men and women farmers find the information and tools contained in the PICSA approach useful and useable. The large majority (97%) of farmers have made changes in their farming practices as a result of the training they have received (mean = 3 per farmer) and the participatory sessions that they have been involved in. These changes are varied (farmers record a range of changes in crops, livestock and livelihood enterprises), dependent on the farmer's individual context and have enabled farmers' to both mitigate risks and take advantage of opportunities. The approach has stimulated farmer's innovation behaviours and encouraged them to actively seek further technical information and resources from extension workers, input providers and their peers *inter alia*.

We posit several reasons why the PICSA approach has been so successful in stimulating innovation by farmers are evident including the following: (i) The emphasis on supporting farmers to make their own choices and decisions and providing them with the tools and information to do this; (ii) Contextualisation (a) Historical climate information provides locally specific evidence for farmers to help in their decision making and (b) the approach enables farmers to focus on their own farm and household context when considering challenges and opportunities and planning ahead; (iii) PICSA is not just about information delivery but it is an integrated approach (a) taking a 'whole farm' approach and not simply concentrating on crops or livestock but acknowledging the farm as an integrated system, (b) bringing together Meteorological Services, Extension and farmers alongside other actors in the innovation system (seed suppliers, credit providers, NGOs etc…) and (c) that enables farmers and extension workers to engage with and use different and complimentary climate information in their planning and decision making (i.e. historical information, seasonal forecast and short term forecasts); (iv) the approach provides a step-by-step framework for analysing and addressing complex issues and linking them to practical management options; (v) information and tools are easily understood and easily shared by extension workers and farmers (including non and semi-literate) yet enable relatively complex analysis and planning; (vi) the step-by-step approach helps extension staff to meet farmers needs/demands and to do their own jobs better; (vii) by providing locally specific evidence and participatory tools for decision making the approach empowers farmers and emphasises the opportunity/ability to act rather than being passively impacted by the local climate; this empowerment also enables farmers to make informed decisions rather than relying on directions from extension workers.

Whilst the evidence in this paper shows that PICSA is an effective approach and can be implemented on a large scale it is not without challenges and there are key issues that need to be considered. To be able to reach scale requires considerable preparation in identifying and working with the relevant stakeholders, building capacity ahead of and during PICSA training for extension workers. Ahead of extension worker training, capacity building within National Meteorological Services is necessary for preparation of climate products as is engagement with agriculture service providers to prepare locally specific agriculture and livelihood information and concerted preparation of logistical arrangements for the training itself and the follow up implementation and support (provision of materials but also field visits). Long term, sustainable implementation requires capacity building within national government and NGOs, ownership by implementing organisations and for the approach to be included in national plans and policies. This is easier to achieve if successful partnerships and implementation of PICSA have been achieved at 'moderate' scale (e.g. covering one or more 'districts').

Dorward P., Clarkson G. and Stern R. 2015. Participatory Integrated Climate Services for Agriculture (PICSA): Field Manual. Walker Institute, University of Reading. ISBN: 9780704915633.

1. Introduction

Smallholder farmers are key to food security in sub-Saharan Africa where more than two thirds of the population depend on small-scale, rain-fed farming as their main source of food and income (OECD/FAO, 2016). Helping smallholder farmers to adapt to, and cope with, climate change and variability is a key global challenge as outlined at COP21 in Paris. Critical farming and household decisions depend upon the weather, for example, how much rain falls, the length and start date of the rainfall season and the timing of dry spells. The implications of a changing and variable climate mean that the role of climate services in agriculture is increasingly important. The growth of the climate services field has seen large scale investment in a wide range of initiatives to improve capacity. Current approaches to climate services at the local level include climate advisories based upon the seasonal forecast, early warning systems for floods and/or droughts, the use of weather based index-insurance, communication of weather forecasts through radio shows and phone-ins.

These approaches have had mixed results in terms of their reach and impact with smallholder farmers. Currently smallholder farmers receive very little if any, locally specific, climate and weather information and little is done to contextualise this information and make it useful for decision making. As Carr and Onzere (2017: 2) point out the body of literature on climate services highlights the need for climate services to be context specific: '*Simply put, it is possible to design climate services that,*

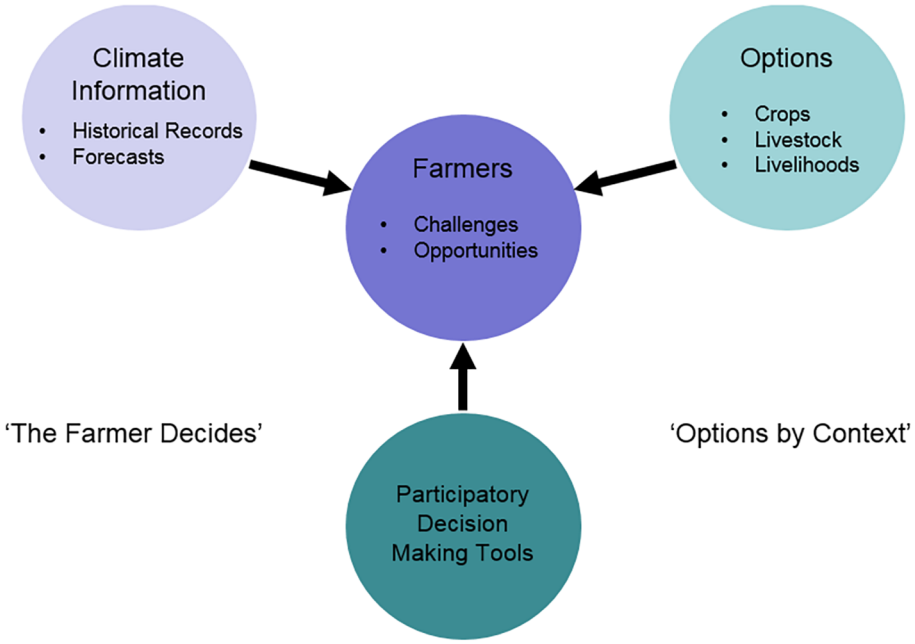

Fig. 1. The principles and core components of PICSA.

in the context of a specific stressor for a specific group of people, work brilliantly, but when applied to a wider group of users for new purposes, fail dramatically.' This speaks to two of the key challenges with climate services currently – the challenges of sustainability and scale. Furthermore, while other papers in this Special Issue deal in more detail with the inherent challenges for Climate Services, it should be noted that logical approaches that integrate information and allow tailored visualisation and simplification according to users' needs while balancing complexity, accuracy and clarity have been a key gap in the Climate Services field.

The Participatory Integrated Climate Services for Agriculture (PICSA) approach has been developed through work in a number of sub-Saharan African countries since 2011 and at the time of writing has been implemented at various scales in 20 countries in Africa, Asia, Caribbean and Latin America. It offers an approach that can be scaled across districts, countries and regions, and builds on extensive practical use of participatory methodologies with farmers. With the farmer placed firmly at the centre of the approach, PICSA aims to help facilitate locally-specific evidence-based decision-making by farmers through analysis of livelihoods, farming systems and climate information, together with systematic and participatory exploration of management options. This paper introduces the PICSA approach and then using the example of Northern Ghana where PICSA was implemented for the first time to scale (more than five thousand farmers in 2015 season) aims to investigate whether and how PICSA affected both i) farmers' decisions and actions and ii) their livelihoods.

2. Approach and methods

2.1. The supporting principles and components of the PICSA approach

Fig. 1 summarises the key supporting principles and components of PICSA. The approach focuses on supporting the farmer in their decision making and planning; hence they are at the centre of the figure. Farmers face both opportunities and challenges (e.g. markets, supplies, weather, pests, new innovations…). PICSA provides information on key challenges i.e. in this case climate and weather, and this includes not just forecasts but also historical climate information (top left of Fig. 1). Improved information, understanding and analysis of climate information is of limited value without exploring the practical actions farmers can take. PICSA therefore includes identification and careful consideration by farmers of the range of options that they could take (top right of Fig. 1) considered for crops, livestock and other livelihoods. A range of participatory decision making tools[1] (bottom of Fig. 1) enable farmers, collectively and individually, to explore and use the climate information, but very importantly to select and plan options that they wish to implement. Options tables for example help systematically explore options and Participatory Budgets (PBs) to evaluate, compare and plan options. Two key principles also underpin PICSA; the first of these is that the 'farmer decides' and the second is 'options by context'. PICSA adopts the 'farmer decides' principle, placing the emphasis on providing information and tools for farmers to make decisions (rather than using information to provide recommendations or 'advisories' for farmers). This is fundamental as the farmer and household (i) take the sometimes life changing consequences (whether favourable or unfavourable) of the decision, and (ii) are best placed to make the decision with their detailed knowledge of their farm, system and environment. This core principle of PICSA is supported by Agricultural Innovation Systems (AIS) thinking (Leeuwis, 2004; Klerkx et al., 2012) which acknowledges that multiple actors are important in providing information and services that can help a farmer in making a decision, whilst stressing that the decision and the reasoning behind that decision must come from the farmer. Since the middle of the last century agricultural extension has been heavily influenced by Transfer of Technology (ToT) and Diffusion of Innovation thinking (Rogers, 2003), with an emphasis on farmer education and even persuasion to adopt researcher designed practices. Despite the emergence of important theories and approaches including Farming Systems Research and Extension (FSRE), Participatory Learning and Action (PLA), Farmer First, and AIS, and notwithstanding some success, ToT has continued to have a strong influence in the design and implementation of agricultural development. Linear approaches continue to be used in both agricultural extension (Klerkx et al., 2012; Röling, 2009) and climate services, often with disappointing results (Andersson and D'Souza, 2014). The second core principle of PICSA is 'options by context' (Dorward et al., 2015),

[1] The participatory tools used in the PICSA approach are fully explained in the field manual (Dorward et al., 2015) which can be downloaded from https://research.reading.ac.uk/PICSA .

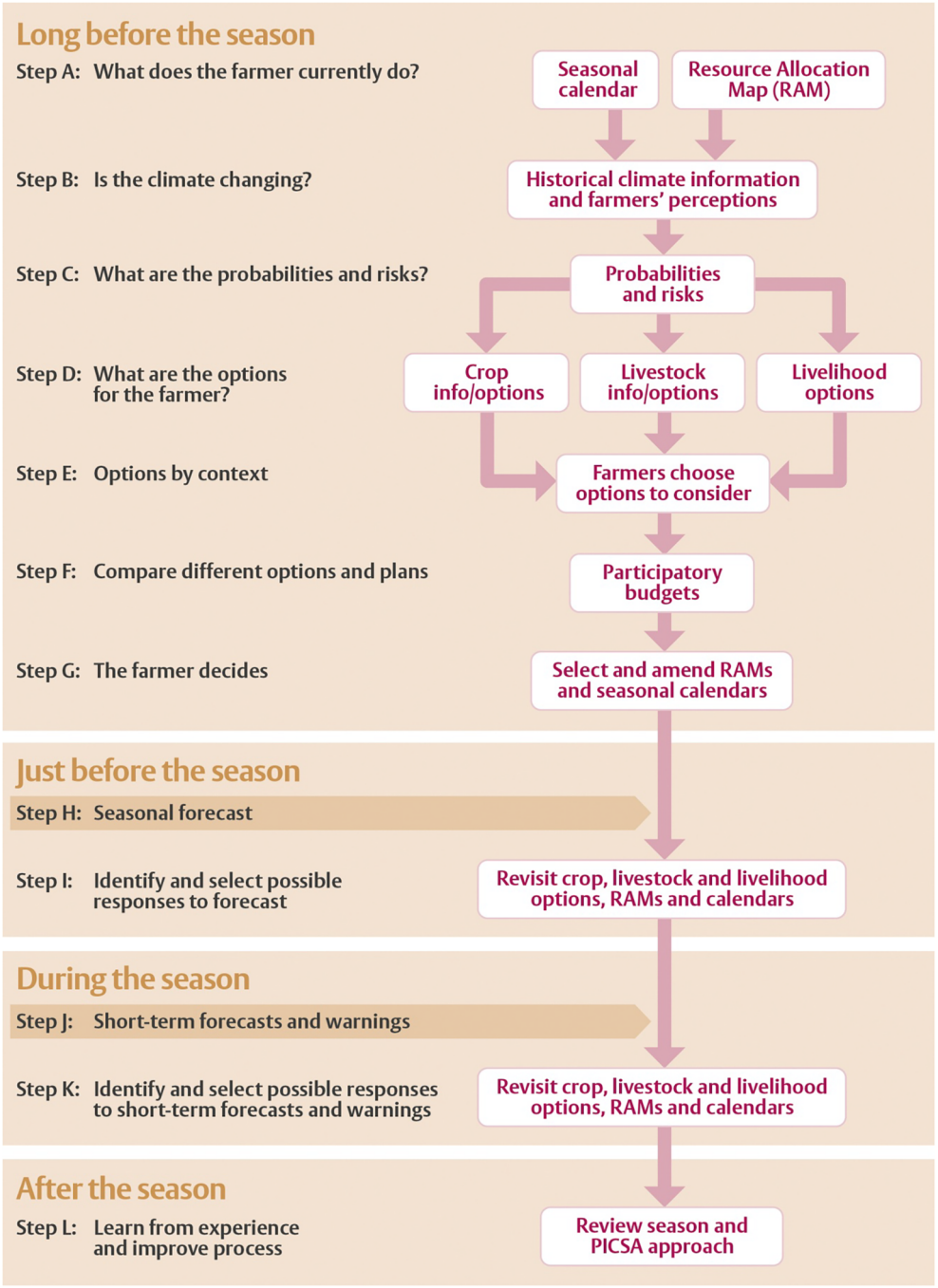

Fig. 2. *The steps of the PICSA approach as presented in the PICSA field guide for intermediaries (*Dorward et al., 2015*).*

which is the understanding that all farmers are individuals with different access to resources, different social characteristics, different attitudes to risk and different goals *inter alia*. The options that are suitable for, or that interest, a farmer are likely to differ from farmer to farmer.

The approach is implemented by trained intermediaries (extension workers, NGO field staff, community volunteers) through a series of training sessions with groups of farmers (usually around three/four sessions 'well before the season' and one session 'just before the season'). PICSA is designed for use with farmers irrespective of their level of literacy and has been successfully used with farmer who are non-literate. Intermediaries are encouraged to work with existing farmer groups rather than setting up new structures for the training. Within these sessions, trained intermediaries facilitate farmers to complete the twelve PICSA steps (Fig. 2). Each of the PICSA steps contain a set of structured 'activities' or 'tools' which enable farmers to consider firstly their own context, their local climate and their options. The first Step (A) enables the individual farmer to consider their own context through compiling a Resource Allocation Map (RAM) and a Seasonal Calendar to clearly outline their current resources, the main activities they undertake on and away from the farm, their timing and how climate and weather affects those activities. Step B then introduces a set of locally specific climate graphs from the nearest available meteorological station which include information on season start dates, season end dates and length of season; amount of rainfall in the season; the number of days that received rainfall during each season, frequency of damaging dry spells and other extreme events; and temperature. Farmers are facilitated to jointly analyse these data to consider whether there are any trends evident and variability, as well as how the graphs

relate to their own experience and perceptions. Step C then trains farmers to calculate simple probabilities from the climate graphs so that they are better able to consider opportunities and risks (e.g. the probability of an amount of rainfall in a given period, dates of onset of season *inter alia*) before introducing 'crop information sheets' that list different crops and varieties alongside information on their crop water requirement and the number of days they require to mature. Steps D & E then move the discussion forward from opportunities and risks to consider specific options. An options matrix (see Dorward et al., 2015: 28) is used for farmers and intermediaries to firstly suggest and then quickly analyse and compare different crop, livestock and livelihood options that may help farmers in the context of their local climate and resources. Step F enables individual farmers to compare the different options and plan using Participatory Budgets (PBs) (Dorward et al., 2003). PBs enable a farmer to consider all of the activities, inputs and outputs (physical and monetary) associated with an option and how this may pan out over a given time period (perhaps a number of weeks for a poultry enterprise, a season for a crop or a number of years for an agroforestry option). Step G is the point at which farmers start to firm up their plans for the season and it is important to note that as it is based upon historical climate information all of these steps happen long before the season. Steps H & I are then introduced 'just before the season' after the seasonal forecast has been released by the National Meteorological Service. Depending on the strength of the forecast and farmers individual contexts they may decide whether and how to adjust their plans in the lead up to the season. Steps J & K cover short-term forecasts (usually one, five or ten day forecasts) and how farmers might better use these forecasts to influence their activities within the season (e.g. might a forecast of heavy rain affect my plans to spray fertiliser today or might a forecast for a dry spell affect my decision to sow)? Step L then happens after the end of the season and is intended to encourage reflection and learning ahead of the next season.

2.2. Methods

Ahead of any PICSA implementation in a new country or region of a country, a scoping visit is undertaken to introduce PICSA to potential partners, gather information on the agricultural systems and where necessary adapt specific parts of the approach to the local conditions, and to assess the availability and quality of historical meteorological data from rainfall stations. Support is provided to the government Meteorological departments where required, in quality checking, management and analysis of historical data. The visit ahead of implementing PICSA in the north of Ghana was undertaken with Ghana Meteorological Agency (GMet) who used the opportunity to visit stations in the region to check and 'rescue' historical climate data that were not in their database. This is an essential preparatory activity ahead of implementing PICSA in a new location. Following the scoping and the preparation of historical climate data the next part of the PICSA process was a 'training of trainer's for Adventist Development Relief Agency (ADRA) staff. This took place in Tamale, Ghana and was a five day training which included a practical day field training to practice some of the tools in the approach. A total of 42 agricultural field officers were involved though some of those attending were from Mali and Burkina Faso. From Ghana there were 28 agricultural field officers and these were a mixture of MoFA and ADRA staff. It is these field officers whose training the rest of this results section will concentrate on.

The 28 trained agricultural field officers then trained farmer groups in a series of meetings to cover the whole of the PICSA approach in six Districts across northern Ghana (Fig. 3). Approximately 4700 farmers across 124 communities in six districts received PICSA training.

As part of PICSA implementation there are monitoring sheets for agricultural field officers to fill out after every one of their meetings with groups of farmers. Farmers were interviewed for short surveys after steps G (when farmers make decisions about the coming season) and L (after the season). In addition to these short surveys, monitoring is conducted during the season through field visits by trained PICSA experts (those who help to train intermediaries). In the north of Ghana implementation in 2015 there were two separate visits by a research assistant who used observation, focus group discussions and in-depth individual interviews with farmers to investigate the impact that PICSA was having on households' decision making. After the season a review meeting was held with all intermediaries that had been involved in the initial training and roll-out of the PICSA approach to be able to hear their thoughts and experiences and to provide support for their interactions with farmers.

In the north of Ghana, initial findings from these elements of PICSA monitoring helped to design a mixed methods approach that combined a quantitative survey of 416 randomly selected households that had received PICSA training and in depth qualitative case studies with 18 PICSA trained farmers. The quantitative survey covered six districts across the northern region of Ghana (see Fig. 3) and each contained communities that had established farmer groups working with ADRA. The quantitative survey was carried out by independent enumerators using tablets and Open Data Kit software[2]. This was followed by qualitative case study fieldwork that involved 18 of those households which were purposively sampled following initial analysis of the quantitative survey data. These households were chosen based upon categorisation drawn from the quantitative survey to make sure there was an accurate representation of genders, those who had made changes in crops, livestock and livelihoods and those that had made no changes based on the PICSA approach. The quantitative survey and qualitative case study methodology were carefully developed and then piloted. The quantitative survey included a range of closed questions, open-ended questions and Likert style statements. The qualitative case studies initially involved mainly open-ended questions to capture farmer reflections and experiences before providing more detail by using PBs and effects diagrams[3] to understand the real impact and effect of changes farmers had made.

The survey and case studies were conducted several months after the 2015 season so after crop, livestock and other livelihood enterprises had been operating for several months following the PICSA activities. The survey and case studies between them investigated what PICSA training farmers had taken part in, what if any changes farmers had made to their crop, livestock or other livelihoods as a result of the PICSA approach, and farmers' perceptions of the effects of the changes on production and their households. Particular care was taken to ensure that participants were accurately reporting the training they had received and that any changes in behaviours were correctly attributed to the training received. For example, in the survey relevant pictures for each stage of the training were shown and participants asked to identify whether they had been trained in them, had understood them and whether they had used them. Once they had been asked about each stage of the training, participants were asked to consider whether they had made any changes in their crops, livestock or other livelihood enterprises specifically as a result of the training. The qualitative case studies, through in-depth discussion, interviewing and observation, also allowed for triangulation to ensure correct attribution of changes and reported effects due to the PICSA training. The research focused mainly on whether and how PICSA influenced farmers' behaviours, and at farmers' perceptions of the effects of their changed behaviours. It also explored farmers' perceptions of their ability and confidence to make decisions, and deal with climate related challenges etc. The research did not seek to look for changes in outputs (e.g. yields) or resources available to households (e.g. assets) through comparison 'before and

[2] https://opendatakit.org/.

[3] An effects diagram is used to identify and, importantly, where possible, quantify the effects (both monetary and non-monetary) of innovations that farmers and households have experienced on their incomes and livelihoods due to changes they have made.

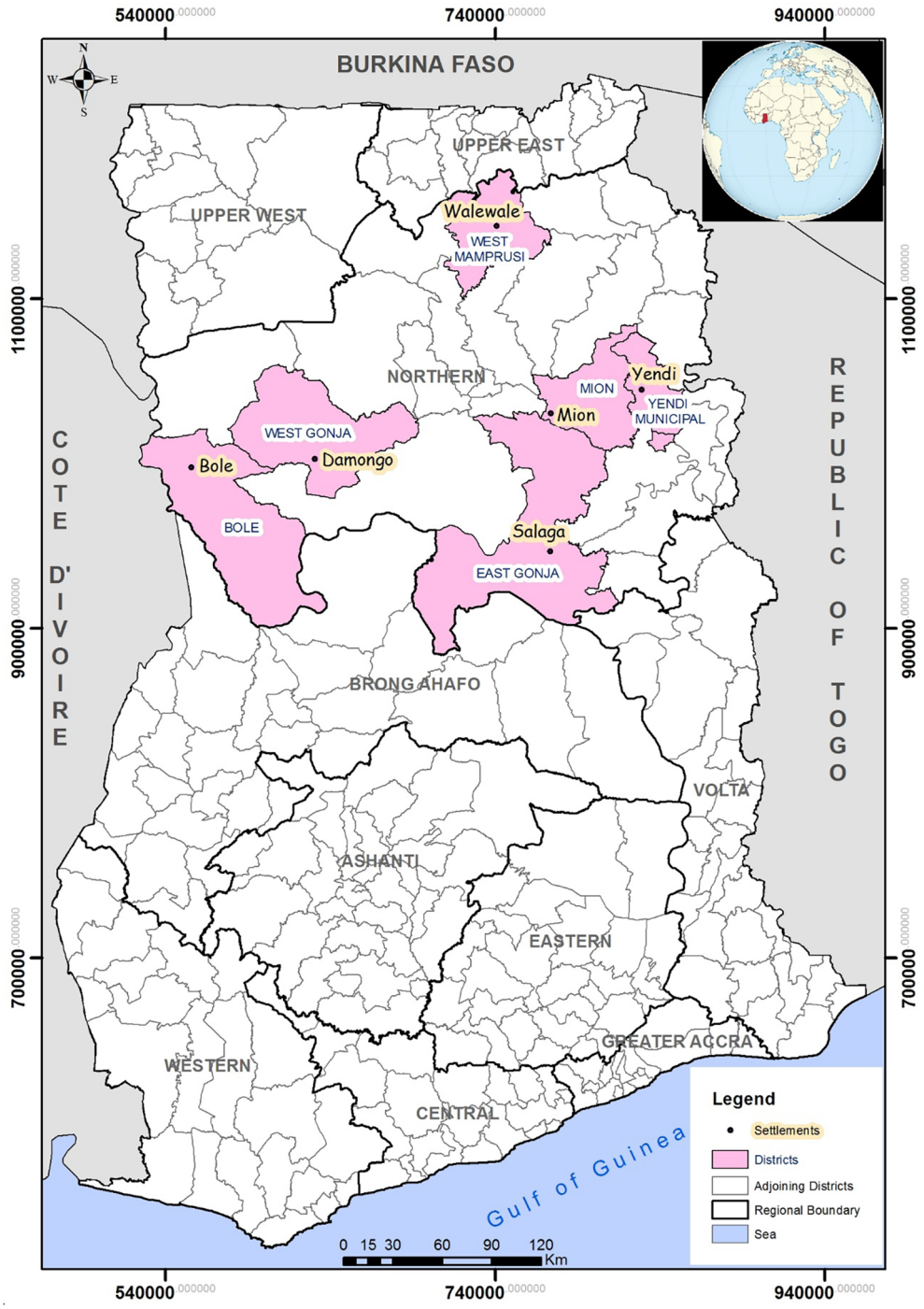

Fig. 3. Map of Ghana showing PICSA training districts.

after' or 'with and without' being involved with the PICSA approach. Variation in rainfall between years (as well as in economic and social conditions) would have considerable influence on production and assets, and it would not be feasible to isolate the effects of farmers' decisions from these. Comparison with farmers who had not been involved in PICSA would also be problematic as it would not be realistic or desirable to try and to stop farmers from sharing information and ideas from PICSA with each other in the same location, and farmers in different locations are likely to experience different conditions e.g. amounts of rainfall in a season given the local spatial variability that exists. The case studies however included exploring in detail farmers' perceptions of both tangible material changes that they attributed to the changed behaviours (e.g. yields and income) and other important benefits they had observed e.g. effects on food security, reduced need to seek employment elsewhere to supplement income and food, greater ability to pay for children's education. Farmers considered their yield and or income in 2015 from enterprises that they had made changes to as a result of involvement in PICSA and using PBs compared them to what they perceived they would have obtained without making the changes (e.g. based on their experience and observations of other neighbouring farms). PBs were used for this to enable detailed construction of budgets which take into account all activities within an enterprise and consider all potential effects of changes in practices e.g. on labour and other inputs (fertiliser, transport) as well as outputs (for consumption and sale).

As explained above, the methods used to investigate the effects of

PICSA did not seek to make comparisons of agricultural performance between seasons. However, to provide context on the season of interest we used the data collected by GMet for rainfall stations relevant to the study areas. These data indicate that the 2015 rainfall season was in the driest third of years[4] historically (i.e. 'below normal') and that the onset of rains were in the later third of years historically.

3. Results

3.1. Social and economic characteristics

Within the sample districts, households were randomly selected from 20 communities. One third (33%) of respondents were female and respondents were from a range of ages (youngest was 17 and the oldest was 90).

The quantitative survey included standard questions from the Ghana Progress out of Poverty Index (PPI[5]). Each respondent was given a PPI score based upon these questions. Scores ranged between 8 and 54. From this, four different wealth categories were created. Table 1 shows that there is no clear bias towards either gender in any of the wealth categories, though the wealthiest group (4) has slightly more male respondents than the other three groups.

Table 1
Respondents by gender and wealth.

Wealth group	PPI score range	Males %	Females %
1	8–23	65	35
2	24–27	67	33
3	28–31	66	34
4	32–54	70	30

3.2. Training received and perception of usefulness of elements of the PICSA approach

Respondents were asked whether or not they received training on the tools after being shown a familiar prompt (picture) from the training which identified each of the individual tools (Table 2). They were then asked whether or not the tools had been useful in their planning and decision making for the coming season.

Overwhelmingly, respondents reacted positively to the different tools and found them useful in their planning and decision making. There was little difference between male and female respondents in their reactions to the different tools.

3.3. Are farmers making changes based on the PICSA approach?

Following the set of questions about different tools in the PICSA approach respondents were asked whether they had made any changes in their crops, livestock and/or livelihood enterprises as a result of the training. Overwhelmingly, respondents said that they had made changes with almost all respondents (97%) making at least one change. Again there was little difference between males (96%) and females (98%).

Most respondents were making changes in their crop enterprises (91%) and there was no difference between males (91%) and females (91%). A smaller number of respondents were making changes in their livestock enterprises (57%) but here there were clear differences between males (70%) and females (30%). Just over a quarter of respondents (27%) had made changes in their other livelihood enterprises with women more likely to make changes (47% of females had made changes compared to 16% of males). Respondents were making changes in more than one type of enterprise with 53% making a change in at least two of the categories of enterprises and 13% making changes in all three (31% made a change in just one of the three categories).

Respondents were, on average making three changes as a result of the training, with a range from no changes to ten changes and a median of three changes. Males were making slightly more changes (average of 3.5 per household with a median of three compared to 2.7 with a median of two for females). Likewise, the wealthiest category were making slightly more changes than the poorest (3.5 changes per household compared with 2.8).

The next sections explore in more detail the types of changes that farmers made. As noted in the description of the PICSA approach earlier, during the steps that consider potential options to address challenges and opportunities, it is farmers themselves who identify a range of changes that they could make rather than the intermediary suggest them and rather than focussing on a small number of innovations that local development organisations may be promoting.

3.3.1. Crop enterprises

The quantitative survey was able to go into further detail as to the different types of changes that respondents were making based on the PICSA approach. Ninety percent of households were making changes in their crops and of these the largest proportion (36%) had grown a new or different variety of crop; men were significantly[6] more likely to have tried a new variety of crop (43% of men compared to 22% of women). The second most popular (and the most popular with female respondents) was changing the way of managing land or crops (29%). Other changes that respondents were making are outlined in Fig. 4. Women were also significantly less likely to have decreased the scale of a crop or stopped growing it completely (24% of men compared to 12% of women).

The following examples illustrate types of changes that respondents were making in their crop enterprises.

3.3.1.1. A new crop of soya beans. One in ten respondents were growing a new crop of Soya beans as a result of the training/information they had received (12% of females and 9% of males). These respondents were growing an average of two acres of soya beans (range: 0.5 acres to 5 acres).

3.3.1.2. A New variety of maize. Almost a third of respondents had started growing a New variety of maize based on the training/information they had received. A larger proportion of men (38%) as compared to women (13%) had decided to try new varieties. On average, respondents were growing new varieties of maize on 3.2 acres of land (range 0.5 acres to 20 acres).

3.3.1.3. Changing the scale of a maize crop. Different respondents reported increasing (11%) and decreasing (15%) the scale of a maize crop based on their ideas during and following the training. Again, men were more likely to make these changes (increase: 13% compared to 8%; decrease 19% compared to 7%). Farmers who increased the scale of their maize crop did so by an average of 1.6 acres (range: 0.5 to 15 acres). Farmers that decreased the scale of their maize enterprise did so by an average of 2.5 acres (range 0.5 to 11 acres). Decreasing areas of a crop was for a range of reasons including to concentrate the application

[4] The relevant stations (Bole, Damango, Salaga, Walewale and Yendi) had between 40 and 55 years of historical rainfall data.

[5] PPI (now renamed as the Poverty Probability Index) is a poverty measurement tool that has 10 questions about a household's characteristics and asset ownership. These questions are country specific and are statistically derived from a large scale survey that includes a wide range of indicators. See: http://www.progressoutofpoverty.org/country/ghana.

[6] The significance of relationships between different variables of interest was determined using the chi-square test with a 5% significance level.

Table 2
Respondents trained in PICSA tools and their usefulness.

PICSA element/tool	Respondents trained (%) [n = 416]	Trained respondents who found the element useful in their planning and decision making [n = between 362 and 416 dependent on number trained in each tool]		
		All trained	Male	Female
Resource allocation maps	98%	98%	98%	98%
Seasonal calendars	99%	98%	97%	97%
Historical climate information	98%	95%	96%	93%
Probabilities and risks	94%	95%	96%	93%
Crop options	100%	99%	99%	99%
Livestock and livelihood options	96%	97%	96%	98%
Participatory budgets	96%	97%	98%	97%
Seasonal forecast	98%	98%	99%	96%
Short-term forecasts	87%	95%	96%	93%

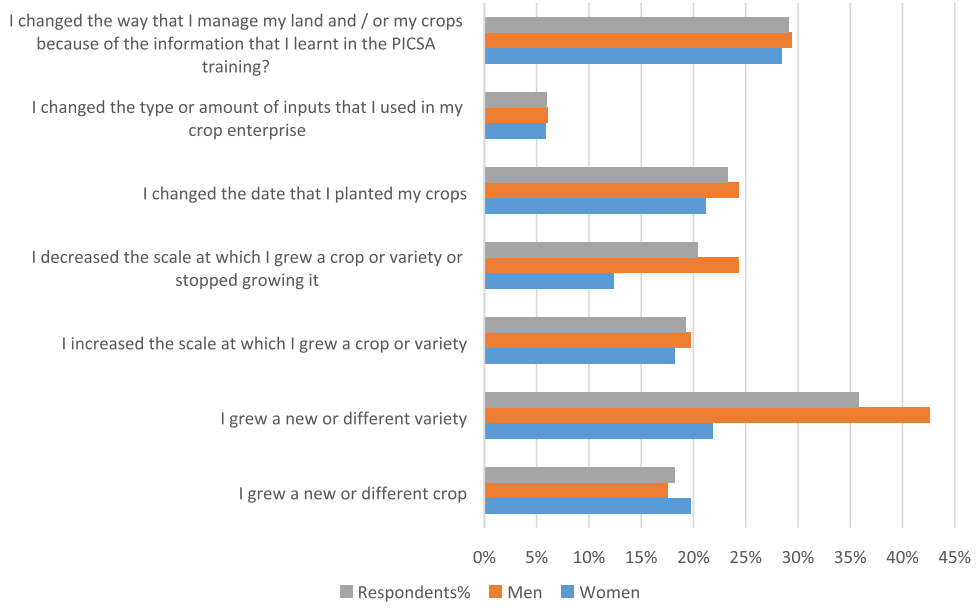

Fig. 4. Changes that respondents made in their crop enterprises as a result of the PICSA training (n = 380).

of inputs on a smaller area, and to release land and resources to expand or introduce other crops.

As indicated above, these changes were not made in isolation and farmers were combining changes to good effect, including changes of variety, timing of planting and other management decisions (e.g. cultivation practices, application of inputs). For example respondent NGP011Q from Mion decided to grow a shorter duration variety of maize at the same time as reducing the scale of his maize crop (from six to three acres) and planting early due to the information in the seasonal forecast; he reported that this helped him to more than double his yield per acre and so achieve an overall increase in yield. Farmer NGP079Q from Yendi increased the scale of his soya beans and also changed from late to early planting as well as implementing planting in rows and using soil and water conservation methods discussed with his extension worker.

3.3.2. Livestock enterprises

More than half the households in the survey were making changes in their livestock enterprises (57%). Men were significantly more likely to make changes in livestock enterprises than women. The most popular change that households had made was to do with the way that they manage their livestock (39%), followed by increasing the scale of a livestock enterprise (19%); men were significantly more likely to make these changes than women (management: 49% of men compared to 19% of women; increased scale: 23% of men compared with 10% of women). Small proportions of respondents either began new livestock enterprises (9%) or decreased the scale of a livestock enterprise (3%) due to the training/information that they had received (Fig. 5).

The following examples illustrate types of changes that respondents were making in their livestock enterprises.

3.3.2.1. Increasing the scale of a goats enterprise. Almost one in ten respondent households (8%) had increased the scale of their goat enterprises. On average they had increased by five goats per household (with a range between one and twenty goats). Respondents reported that the increase in scale of their goat enterprises had increased income levels and enabled them to more easily cope with outgoings such as school fees and medical costs.

3.3.2.2. Changing the management of a sheep enterprise. Changing the management of a sheep enterprise was popular with male respondents (23%), more so than females (5%). These changes include improving the medical care of the animals, improving housing/shelter and improving feed/stall feeding.

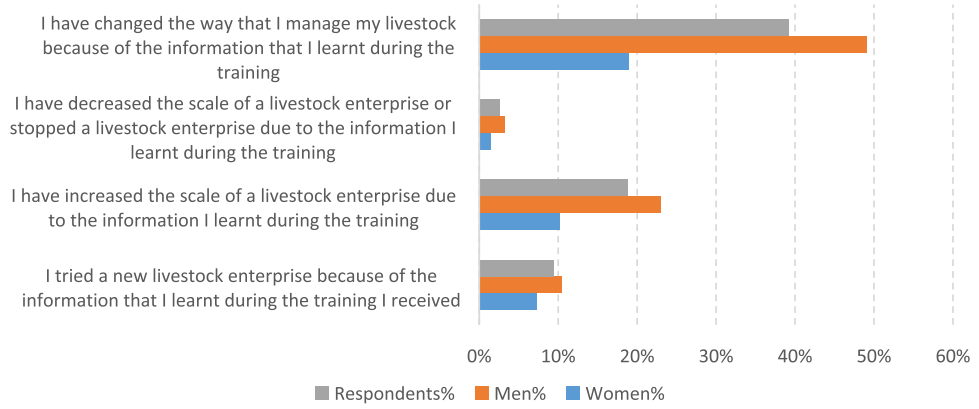

Fig. 5. Changes that respondents made in their livestock enterprises as a result of the PICSA training (n = 237).

For example, respondent NGP357Q had increased the number and improved the health of her livestock through improving the management of her animals. She combined the use of vaccinations with supplying better food ('*clean food*') and feeding them on a regular basis; stating that she now has *'the urge to dip my hand into my purse to pay the veterinary officer to come and vaccinate my animals'*. Respondent NGP410Q had improved the management of his sheep and goats by vaccinating, supplementing their feeding and providing a clean shelter for them. The training also encouraged him to search for further information from his agricultural extension officer.

3.3.3. Other livelihood enterprises

Around a quarter of the households in the survey (27%) had made changes in their other livelihood enterprises[7] as a result of the training they had received. Livelihood changes were significantly more popular with female respondents (47%) than their male counterparts (16%). The most popular changes were to change the management of (12%) or to increase the scale of a livelihood enterprise (11%); both of these were significantly more popular with women than men (management: 21% of women compared to 8% of men; increase scale: 23% of women compared to 4% of men). A smaller number of respondents (6%) had tried a new livelihood enterprise following their involvement in the training (Fig. 6).

The following examples illustrate types of changes that respondents were making in their other livelihood enterprises.

3.3.3.1. Increasing the scale of a petty trading enterprise. All of the ten households that increased the scale of their petty trading enterprise had benefited from the increase in scale. Respondents were asked to put a monetary value on the benefit they had received and there was a range of 20GHC[8] and 1500GHC and an average of 250GHC.

3.3.3.2. Increasing the scale of a charcoal selling enterprise. Another ten households increased the scale of their charcoal selling enterprise as a result of the training they had received. When asked the monetary benefit they considered this change to have made respondents answers ranged between 10 and 300GHC and an average of 133GHC.

3.3.3.3. Changing the management of a food crop selling enterprise. Five female and five male respondents reported changing the management of a food crop selling enterprise as a result of engaging in the PICSA approach. These changes included keeping records of incomings and outgoings, building up whole bags of maize to keep track of prices before selling, waiting for prices to increase at the market before selling and improving standard of food for sale. Nine out of the ten households had benefited from the change that they had made with the range being from a decrease of 100GHC to an increase of 2000GHC. The average difference per household was an increase of 575GHC due to the change that they had made.

Respondent NGP198Q discussed the impact that the participatory budgeting had on her firewood enterprise. The budgeting encouraged her to see this enterprise as more of a business that she could make a profit from to invest in other enterprises, such as her groundnut farming. The budgeting helped her to see that expanding the scale of her firewood enterprise would increase her profit margin.

3.3.4. Would respondents liked to have made more changes in their enterprises?

Overwhelmingly, respondents said that they would have liked to have made more changes on the back of the training/information that they received. The main reason why respondents felt unable to make more changes in their enterprises was due to a lack of money. This was the case for crops (88%; 92% of females and 85% of males), livestock (90%; 94% females and 88% males) and livelihood enterprises (91%; 93% of females and 90% of males). For crops the main other reasons why respondents felt they were unable to make changes included the high risk of an unfavourable season (40%; 42% males and 36% females) and limited access to inputs and resources (35%; 36% males and 33% females); for example farmer NGP015Q wanted to plant soya bean but decided because of the forecast that there would not be enough rainfall and farmer NGP079Q wanted to increase the scale of his maize farm but couldn't due to a lack of finances. For livestock the other reasons were the high risk of an unfavourable season (11%; 14% males and 6% females) and a high risk of pests (10%; 13% males and 4% females). When considering livelihood enterprises the other main reasons respondents were unable to make more changes were a lack of access to inputs (13%; 18% females and 11% males) and a lack of technical knowhow (11%; 13% males and 7% females).

3.4. What effect are these decisions and changes having on farmers and their households?

The evidence presented above clearly shows that farmers are making changes based on the PICSA approach and this next section investigates the impact that these changes are having on the farmers and households who are making them. The effects that farmers and

[7] There were 15 different types of other livelihood enterprises recorded by participants and these included shea butter extraction, petty trading, food crop selling, livestock selling, charcoal selling, firewood selling, pito brewing and selling, taxi driving, butchering, thatched grass selling, rice par boiling, weaving mats, tailoring, mechanic and mason.

[8] At the time of the survey the currency rate was 1USD = 3.82GHC.

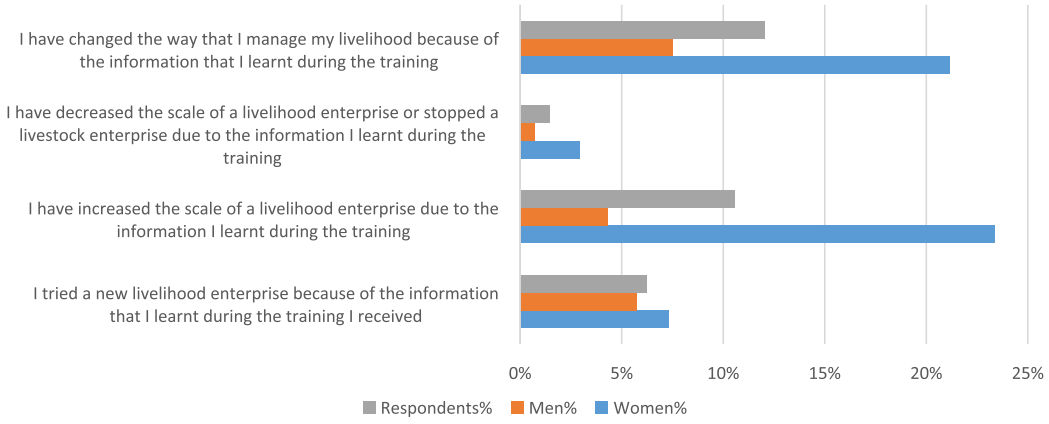

Fig. 6. Changes that respondents made in their livelihood enterprises as a result of the PICSA training (n = 110).

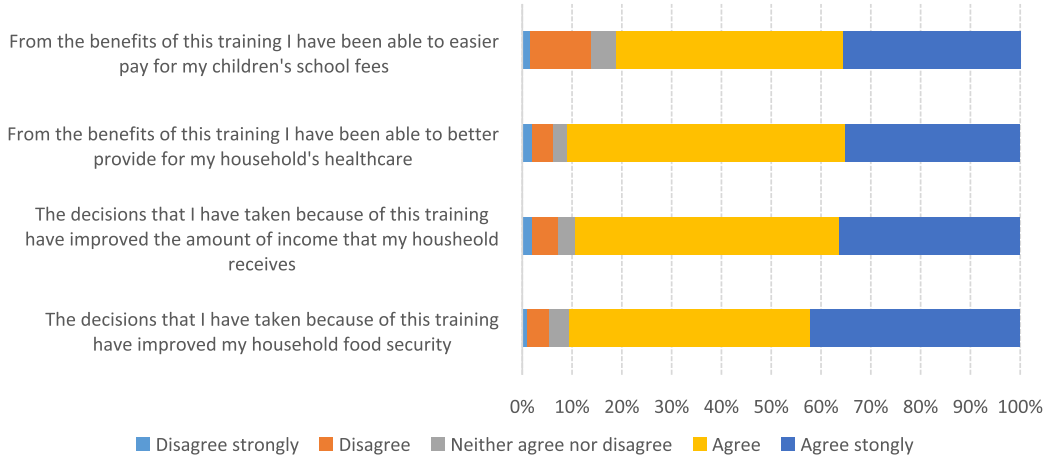

Fig. 7. Likert style statements regarding the effect of the PICSA training.

research staff had reported or observed from field visits to farms and from focus group discussions prior to the survey or case studies, were used to develop statements that were explored through a Likert type scale.

Respondents stated that the decisions they had taken based on the training had direct impacts on their household (Fig. 7). They reported that training had improved their household food security (91% agree or strongly agree), the income that the household receives (89%), made them better able to provide for the household's healthcare (91%) and better able to pay for their children's school fees (81%).

Social standing in the household and the community had also improved for those farmers that had received training. Nine in ten

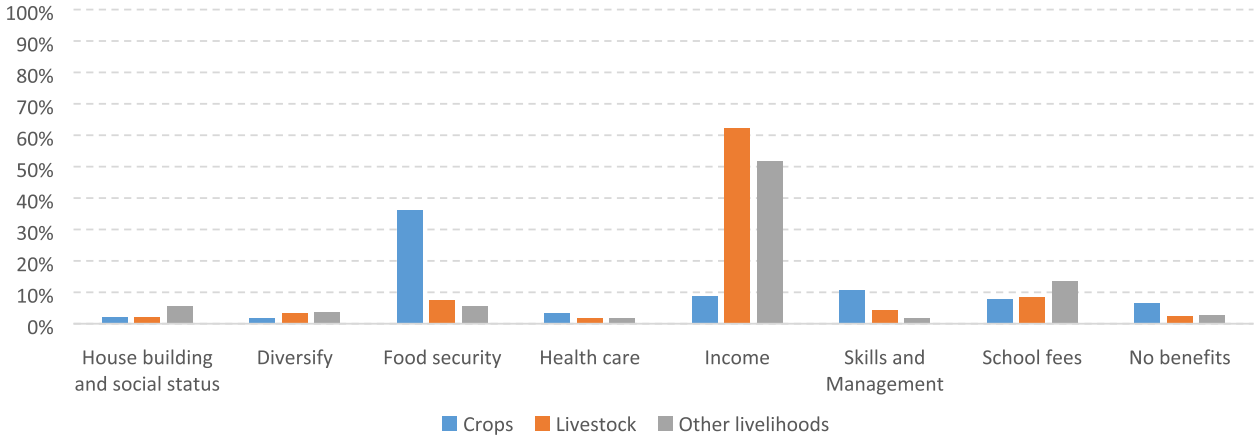

Fig. 8. Categorised benefits for respondents (crops n = 380; livestock n = 237; livelihoods n = 110)).

respondents reported that they had improved their social standing within their own household and within their communities.

Using the quantitative survey tool the research team were able to gain insights into some of the benefits that respondents described (Fig. 8). Benefits described by farmers included improvements in income, food security, health care, ability to pay school fees, skills and management of enterprises and improved social status. The most important benefits were food security and improved income. The responses were different for the different enterprises. The changes that respondents were making in crops were seen by respondents as more beneficial with regards to food security whilst livestock and livelihood enterprises were considered more beneficial with regards to income. Some examples of statements from respondents are included to illustrate the wide range of types of benefits reported. '*I have started building my own house out of the sale of my crops*', '*I have been able to open a shop from the sale of my produce*', '*I have stopped buying foodstuff for consumption because I have enough food to consume*', '*even though the rains have been bad, we were able to get some small to feed our families*', '*I sold two bags and paid my children's health insurance*', '*it has increased my knowledge in farming activities and it has helped me to manage my farm well because if not for the training, I would not have gotten anything this year as the rains were bad*', '*it has built my capacity financially and also improved my knowledge to cope with bad weather during the farming season*', '*this year I roofed my house as a result of the sale of the animals*', '*because the animals are in good health I can sell them at a high price*', '*I now get a better price for my cattle as they are healthy*', '*now that I am into livestock sales I am making profit unlike the butchering where I make some losses*'.

The qualitative work involved revisiting 18 respondents who were selected from the quantitative survey to be investigated in greater detail as to how the PICSA training had influenced their decision making process and how changes that they may have made had impacted upon their household. There were eleven male respondents and seven female respondents in this phase of the fieldwork. Sixteen of these had made changes influenced by PICSA (Table 3) and two hadn't made changes based on the training. Eleven of the changes discussed in detail were in crops, four in livelihoods and one in livestock.

The evidence in Table 3 again demonstrates the sheer variety of different changes that resulted from farmers engaging with the PICSA approach. Crops, livestock and other livelihood changes that include new crop varieties, changes in scale of planted crops and rate of input application, changes in planting date, weeding regimes, management of livestock (feeding, veterinary regimes *inter alia*) and beginning new and changing management of 'other livelihood' enterprises (food crop selling and firewood selling). Also striking is the range of impacts reported where common themes include improved food security, paying children's school fees, re-investing profits in agriculture, livestock or in improving household structures. Respondent's also reported changing resource use (such as using manure from chickens instead of synthetic fertiliser) as well as social impacts such as improving their standing in the community, improving the 'independence' of household members and helping children to concentrate on their schooling.

3.5. How have farmer's confidence and perceptions of their own ability changed as a result of PICSA training?

Respondents were asked to assess how the training had impacted on their confidence and perceptions of their own abilities through a series of Likert statements that were designed through analysis of the initial monitoring of the PICSA approach. Overwhelmingly, respondents said that the training they had received had made them more confident in planning and decision making about their farming and livelihood enterprises (Fig. 9).

Respondents also stated that (more than 85% of respondents strongly agreed or agreed with the statements) they felt better able to cope with bad years caused by the weather; more confident to discuss ideas with their peers following the training; that the training had influenced their planning and decision making over the past season; that the training had improved those decisions; and that they now see farming as more of a business than previously.

Some farmers attitudes to scale changed as a result of the training; farmer NGP011Q stated that he has learnt that '*it is not about how big your scale is but how you are better able to manage your land to get the benefits*'. Farmer NGP015Q discussed searching for more information on the back of the training, from other providers and family members; NGP079Q similarly approached his extension worker for further information about the optimal use of different inputs; NGP322Q changed her attitude towards farming and decided to bring in some hired labour to help keep control of the weeding on her farm and improve her yield. The participatory budget had encouraged farmers to see their livelihoods as more of a business; farmer NGP104Q talked of considering different costs that she had never counted against her profit (such as transportation costs); farmer NGP223Q had decided to increase the scale of his Soya Beans enterprise because he saw this as an opportunity to increase his income and take care of other needs in the household. One of the clearest changes from farmers was the greater consideration of weather and climate; farmer NGP129Q now uses the historical climate information to choose the most suitable crop varieties for his farm. Farmer NGP198Q decided on the back of the training to diversify her livelihood and ensure she was not '*only diverting her effort into one area*'.

Respondents also reported that they had been sharing the knowledge/ideas that they had taken from the training with their peers (84% of respondents had shared information with their peers). A larger proportion of males (90%) were sharing information than females (72%). On average respondents were sharing information with five of their peers (three males and two females). Most of these were sharing with smaller numbers of farmers but some were sharing with groups of between 10 and 30 farmers. All participants in the qualitative research spoke of sharing the information from the training (whether it be the seasonal forecast, the livelihood options, participatory budgets and how to take care of animals) with family members and with their peers; NGP011Q for example stated that he '*discussed the training with 4 people from a community close to his who were not part of the meeting*' and reported that they were '*doing well*' and NGP186Q '*discussed the fast maturing varieties*' with his friend '*because he did not know that the time for planting had almost passed when he was going to start his farming*'.

3.6. Innovation behaviours with respect to accessing information and resources

The training encouraged most of the farmers to discuss with their family and peers and to share ideas, thus helping them to contrast and compare and gain confidence in their plans and the decisions they were making (NGP011Q; NGP053Q; NGP129Q; NGP186Q; NGP223Q; NGP322Q). Others decided that they needed to search for more specialised advice from extension workers, NGO field staff and the radio (NGP015Q; NGP053Q; NGP079Q).

Farmer NGP412Q borrowed money from a local savings fund that she pays into with her peers to increase her use of inputs and hire some labour on her farm; farmers NGP222Q (brother) and NGP322Q (husband) borrowed money from their families to pay for inputs into their farms; and farmer NGP223Q sourced seeds from his farmer group to increase the scale of his soya bean enterprise (he paid them back with seeds at the end of the season). Several farmers invested in inputs for existing enterprises (NGP129Q) and start-up costs for new enterprises; NGP410Q sold three fowls to pay for the seed for a new variety of beans.

Some decided that, due to what they had learnt during the training they were able to provide advice for their peers, advising family members about their decisions and encouraging them to try new ideas (NGP079Q; NGP198Q; NGP357Q; NGP410Q). Also, sharing information directly from the training (such as the seasonal forecast [NGP222Q] or participatory budgeting [NGP015Q]).

Table 3
Changes influenced by PICSA training and associated impacts.

	Gender	Changes	Impact
NGP011Q	Male	Reduced his maize farm from six acres to 3 acres which reduced inputs. Other changes included using early maturing maize and planting earlier. He also kept track of his activities through budgeting.	This helped him to increase his yield by 3 bags from 10 to 13 100 kg bags. He reduced his cash losses by GHC1049 and the extra bags fed his family for four months. Money saved enabled him to purchase zinc to roof his house, pay school fees, and purchase a goat.
NGP015Q	Male	An estimated increase in the number of birds to maximise profit.	She paid her sister's school fees and bought books. The birds' droppings were used as manure on the crop farm. This also increased her social standing in the community.
NGP053Q	Male	Started to vaccinate his cows due to discussions he had at the training.	The vaccinations have reduced the number of his animals dying and has increased his income. He has used the income to pay school fees for family members and buy fertiliser (9 bags). The manure has been useful on his farmland, helping to make savings and increase profits there, and milk from his cows has helped as nutrition for his family.
NGP079Q	Male	Increased the scale of his soya bean from 2 to 4 acres which increased his soya bean yields from five to nine 100 kg bags.	He made an extra GHC43 which has been used to pay his ward's school fees (GHC5 yearly) and to help his wife to start petty trading which he believes will enable her to become more independent.
NGP104Q	Female	Planted earlier due to the training she received which suggested there wouldn't be enough rains for the season.	She made a profit which she reinvested in her petty trading business. She paid school fees for her wards and for her brother. She bought food to cover the loss of produce for consumption.
NGP110Q	Female	She now keeps her produce until the market value improves.	She will use profits to invest in more bags of produce that she can then keep and sell when the price increases. The profits will be invested in school fees and pocket money for her children to improve school performance.
NGP129Q	Male	He reduced his maize enterprise from six acres to four acres Other changes included the adoption of early maturing variety, early planting and better planning using a budget. Increased his yield from ten 100 kg bags to thirty 100 kg bags.	He made GHC403 as well as an extra six bags of maize. Half of the profit went on replacing the zinc on his roof and some of the rest for his children's pocket money. The extra maize will help to cover for 8 months family food and his status in the community has improved because of his success.
NGP160Q	Male	He reduced the scale of maize from four acres to two acres which improved his management. He has also started applying fertiliser which increased his yield.	He has stored four extra bags of maize which he estimates will feed his family for 8 months. This will also provide seed for the next season. He did however make a cash loss (an extra GHC240) which he is disappointed with.
NGP198Q	Female	She increased the scale of her firewood enterprise.	She raised an extra GHC311 from her firewood enterprise which she invested back into food for the family, pay her son's school fees and buy empty sacks for her charcoal business.
NGP213Q	Male	He started vaccinating his birds which has reduced their mortality. He increased the feeding regime to three times a day which has increased production.	He reduced his losses by GHC71, had eggs for consumption and remained with 17 (each worth around GHC20) more birds. The money saved will be spent on a goat to begin a goat enterprise which he hopes will grow, providing meat and also manure which will save money spent on inorganic fertiliser.
NGP222Q	Female	She grew a shorter maturing variety which increased her yield from 15 kg to 400 kg whilst only increasing her inputs by GHC80. The increased harvest did increase the family labour by 25 person days.	The increased yield will help her to feed her family for six months and also provide seeds for planting in the next season. This means that she and her husband do not have to spend money on food.
NGP223Q	Male	He increased the scale of his soya bean enterprise from 1 acre to 2.5.	He received an extra 28 bags of which 7 will be used as food and seed for the next season and the remainder for sale. The sale of 21 bags will bring in an estimated GHC1141 which will help to build rooms in his house as well as a donkey and cart to bring his produce from the farm to the market. Some of the extra money was used to settle school fees also.
NGP322Q	Female	Weeding on her groundnut farm has increased her yield from one to six bags.	The extra GHC690 was used partly for school fees and to buy books. She will invest the rest in petty trading, the profits from which will be invested back into her farming.
NGP357Q	Female	She started regularly feeding and vaccinating her livestock. Previously they used to be left to graze.	Part of the GHC210 increased profit from selling her sheep was used to pay for school fees which will enable her son to complete school and help him to start providing for the family. Some of the profit was used for food and the rest invested into her livestock enterprise (purchasing 2 more sheep).
NGP410Q	Male	He planted beans earlier than previously which has improved his yield.	His produce for the household decreased but the increase in income enabled him to buy food. He also bought a sheep from the GHC581 difference (incl. profit of 395) and improved his roof. He also helped with his wife's health problems through buying medicine.
NGP412Q	Female	Moving her planting date earlier has increased her yield from three to seven bags of maize.	The extra GHC780 she made will be used to purchase a cow and a hen. These investments will bring further knock on benefits of food and manure for the farm. She also had one extra bag of maize.

4. Discussion and conclusion

This paper explores whether PICSA affected farmers' decisions and actions and their livelihoods. In this section we consider the above but also explore why PICSA has been so successful in influencing farmer's innovation behaviours. Results from the survey and case studies have revealed interesting findings which complement and support each other. Both provide clear evidence that most farmers are using the tools and information and as a result of undertaking the PICSA approach almost all (97%) made changes to their practices. A very wide range of changes were identified including both on and off farm, starting new enterprises, and making changes in management of existing enterprises regarding practices, scale and timing. Results from the questionnaire and case studies both reveal how these changes have impacted on households and livelihoods. The case studies enabled in-depth description by farmers and detailed interrogation and checking of results by researchers with farmers. Both the survey and cases studies revealed positive effects on food security and income but also importantly on farmer's wellbeing, confidence in their abilities to plan and deal with climate change and variability, and their status in the community.

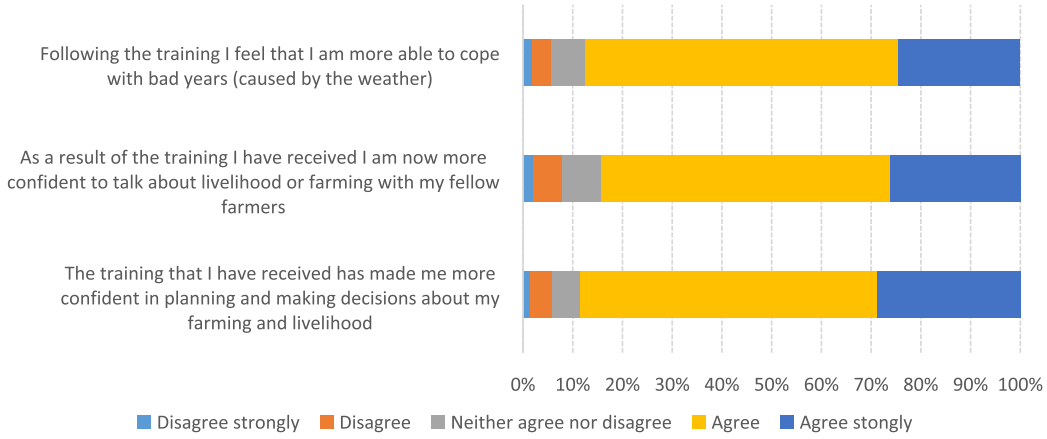

Fig. 9. Likert style statements regarding respondents confidence and perceptions of their own ability following PICSA training.

There were significant differences between men and women in terms of the types of changes they made as a result of the training. While men and women were equally likely to make changes in crops, men were more likely to make changes with regards to the type of variety of crop chosen and whether or not to decrease scale or stop growing a crop altogether. Livestock and other livelihood changes were split by gender with men more likely to make changes in livestock (specifically with regards to the management of livestock and the scale of the enterprise) and women more likely to make changes in livelihoods (again, specifically with regards to management and scale of the enterprise). These differences are likely to be linked to existing power dynamics with regards to decision making within the household (see Zakaria et al. 2015) but requires further research in order to be able to explore the influence of PICSA on these power dynamics.

That almost all participants made one or more changes to their activities as a result of an initiative/ intervention is unusual and adoption rates of new technologies and/or practices can be considerably lower (Fisher et al., 2015; Kassie et al., 2013). Similar results have been observed in evaluations of PICSA in Malawi (Steinmüller and Cramer, 2017) and Rwanda (Clarkson et al., 2017). What is also striking from the results is not only the great variety of changes that farmers considered and made, but how each farmer interviewed explained the rationale for their changes, and how they related to that farmer's own context: why they reduced scale of a crop grown, increased scale of another, changed the proportions of scarce resources allocated to different enterprises, diversified into a new enterprise, planted a crop at a different time, vaccinated animals etc. Farmers were actively exploring and considering different options for their own individual contexts both within, and very importantly, outside and after the PICSA related meetings. Further, many reported how they actively sought and obtained further technical information (e.g. from their extension worker, other providers, family members) and resources such as labour, seeds and cash (e.g. from suppliers, extended family) required to make changes.

Whilst it is not the focus of this paper to explore in detail the reasons why PICSA is stimulating innovation and behaviour change, we posit, drawing on observations from the work in Ghana and in other countries, the following: (i) The emphasis on **supporting farmers to make their own choices and decisions** and providing them with the **tools and information** to do this; (ii) **Contextualisation**- (a) Historical climate information **provides locally specific evidence** for farmers to help in their decision making and (b) the approach enables farmers to focus on their own **farm and household context** when considering challenges and opportunities and planning ahead; (iii) PICSA is not just about information delivery but it is **an integrated approach** (a) taking a 'whole farm' approach and not simply concentrating on crops or livestock but acknowledging the farm as an integrated system, (b) bringing together Meteorological Services, Extension and farmers alongside other actors in the innovation system (seed suppliers, credit providers, NGOs etc…) and (c) that enables farmers and extension workers to engage with and use different and complimentary climate information in their planning and decision making (i.e. historical information, seasonal forecast and short term forecasts); (iv) the approach provides a **step-by-step** framework for analysing and addressing complex issues and linking them to practical management options; (v) information and tools are easily understood and **easily shared** by extension workers and farmers (including non and semi-literate) yet enable relatively complex analysis and planning; (vi) the step-by-step approach **helps extension staff to meet farmers needs/demands** and to do their own jobs better; (vii) by providing locally specific evidence and participatory tools for decision making the approach **empowers farmers** and emphasises the opportunity/ability to act rather than being passively impacted by the local climate; this empowerment also puts the responsibility on farmers rather than extension workers.

The above suggest that the PICSA approach both in its design and the way it is influencing innovation behaviours of farmers, is in stark contrast to linear dissemination of technology models (Rogers, 2003).While it has long been argued that such 'transfer of technology models' are inappropriate for the complex conditions of resource-poor farmers (e.g. Chambers and Jiggins, 1987; Giller et al., 2009), linear approaches continue to be used in both agricultural extension (Klerkx et al., 2012; Röling, 2009) and climate services, often with disappointing results (Andersson and D'Souza, 2014).

Whilst the evidence in this paper shows that PICSA is an effective approach and can be implemented on a relatively large scale (approximately 4700 households were reached by 28 extension workers) and has the potential to go to national scale (as has subsequently been achieved elsewhere) it is not without challenges and there are key issues that need to be considered. To be able to reach scale requires considerable preparation in identifying and working with the relevant stakeholders, building capacity ahead of and during PICSA training for extension workers. Ahead of extension worker training, capacity building within National Meteorological Services is necessary for preparation of climate products as is engagement with agriculture service providers to prepare locally specific agriculture and livelihood information and concerted preparation of logistical arrangements for the training itself and the follow up implementation and support (provision

of materials but also field visits). Long term, sustainable implementation requires capacity building within national government and NGOs, ownership by implementing organisations and for the approach to be included in national plans and policies. This is easier to achieve if successful partnerships and implementation of PICSA have been achieved at 'moderate' scale (e.g. covering one or more 'districts').

The underpinning principles and design of PICSA were intended to provide a novel extension and climate services approach that enables farmers to be genuinely at the centre of and supported in the innovation process. The results indicate that this has had the desired effect of stimulating innovation behaviours and catalysing farmers to identify, plan and implement changes that address their own individual farming systems and contexts. We would encourage and are undertaking further research on the effects of PICSA on extension professionals and systems and the effects of peer-to-peer sharing of elements of the approach in different countries and regions.

Funding sources

This work was partly funded by the CASCAID (Capacitating African Smallholders with Climate Advisories and Insurance Development) project within the frame of the CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS), which is a strategic partnership of the CGIAR and Future Earth. The CCAFS Program is carried out with funding by CGIAR Fund Donors, the Canadian International Development Agency (CIDA), the Danish International Development Agency (DANIDA), and the European Union (EU); with technical support from the International Fund for Agricultural Development (IFAD).

Declaration of interest

None.

Acknowledgements

The Ghana Meteorological Agency and Adventist Development Relief Agency (ADRA Ghana).

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