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Exploring the effects of a participatory climate services approach on smallholder decision-making in Rwanda using a gender lens

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ABSTRACT

Effective climate services are crucial in supporting farmers to adapt to climate variability and change. Different factors may hinder certain types of farmers in accessing, using and benefiting from climate services. Participatory Integrated Climate Services for Agriculture (PICSA) is a climate services and agricultural extension approach that has been used in more than 20 countries. PICSA has empowered women and men farmers in their planning and decision making and led them to make beneficial changes. Over 112,000 farmers were trained in Rwanda. Results from a large-scale quantitative survey and qualitative case studies with selected farmers are analyzed by gender, headship and wealth to enable understanding of how different farmers access, use and benefit from the information and tools that make up PICSA. Almost all respondents made changes in their farming and/or other livelihood enterprises as a result of the training. The majority of farmers reported that the changes they had made were beneficial, however, a key finding is that in some cases women heads from the least wealthy categories are less able to benefit. This paper provides insights on how gender, headship and wealth status influence responses to climate information and decision-making tools and in so doing highlights important implications for the design of climate services and similar interventions.

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Introduction

Smallholder farmers are key to food production in the Global South, and they are uniquely exposed to the negative impacts of climate variability and change. Despite this, development interventions and policy have largely failed to enable smallholders to cope with and adapt to the challenges they face. In order to enhance

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smallholders' agricultural production capacities and improve livelihoods, climate services have been deemed crucial in supporting smallholders' decision making in agriculture activities. Climate services include the provision of climate and weather information and decision-support tools. Effective climate services empower farmers to select appropriate on and off farm livelihood activities that are likely to succeed in their local climate.

Whilst information and services are crucial to support smallholder farmers it is essential to understand the power imbalances, especially those related to gender, that may affect individuals and groups' abilities to access, use and benefit from them. Due to the socially ascribed responsibilities and roles that women and men carry out in their households and communities, their livelihood strategies, perceptions of and responses to climate risk, and consequently, their needs for climate services may differ (Bee, 2016; Carr & Onzere, 2018; Kristjanson et al., 2017; Rengalakshmi et al., 2018). Normative structures and institutions that influence gendered control of productive resources often disadvantage women's ability to use climate information for their livelihood decisions (Gumucio et al., 2019).

Other identity traits in addition to gender can influence capacities to use and benefit from resilience-building interventions, including climate services (Carr et al., 2016; Carr & Onzere, 2018; Fisher & Carr, 2015). Recent research highlights a knowledge gap in understanding user needs according to the intersection of identity categories (Gumucio et al., 2019). For instance, differences related to headship[1] and poverty, in conjunction with gender, influence access to key social networks, assets, and human resources important for adopting risk-reducing production technologies and engaging in agricultural innovation (Fisher & Carr, 2015; Otieno et al., 2021). With this in mind, it is important to consider not just differences between women and men, but more so which types of women and men use and benefit from climate services interventions.

Therefore, assessing the access, use and benefits of climate services with intentional focus on different groups including different categories of women (women heads of households and women spouses) is critical to understand the impacts of designed climate services and to what extent they benefit different groups. While there exists climate services research that carries out sex disaggregated data collection and analysis, few studies actually recognize that women's climate risk perceptions and livelihood management strategies vary according to headship and other social identify variables (except for Carr & Onzere, 2018; Carr et al., 2016).

Participatory approaches have the potential to support farmer decision making by allowing them to apply tools and develop livelihood management strategies appropriate to their needs. However, while participatory climate services approaches have supported farmer decision making, they may not always benefit all farmers due to factors specific to their socio-political context, disadvantaging some more than others (Rengalakshmi et al., 2018; Roncoli et al., 2003; 2009). The Participatory Integrated Climate Services for Agriculture (PICSA) approach specifically aims to empower farmers to make decisions that are best suited to their own individual contexts, challenges, and opportunities. The approach has been implemented in more than 20 countries to date and evidence shows that women and men farmers have benefited from the

decisions they have made as a result of the training (Clarkson et al., 2019; Dorward et al., 2021; Staub & Clarkson, 2021). As part of the Rwanda Climate Services for agriculture project PICSA was implemented in all 30 Rwandan districts between 2016 and 2019, one of the largest implementations of participatory climate services globally to date.

This paper provides insights on how gender, wealth status and headship influence individual and household responses to the PICSA approach. We assess, with an intentional focus on different categories of women (household heads and spouses) and men (household heads), farmers' understanding of and responses to the climate information and participatory decision-making tools that constitute the approach. We also analyze the effects of the changes made in respondents' farming and non-farming livelihood enterprises. The findings in this paper address a knowledge gap concerning the influence of gender, wealth and headship on access to, use of and benefits from participatory climate services and in so doing highlight important implications for the design of climate services and similar interventions. A recent review and learning agenda (Carr et al., 2020) on the effectiveness of rural climate services emphasizes critical knowledge gaps surrounding how to understand and identify climate services' user needs; our paper constitutes one initial step in filling these knowledge gaps. Although it might be well-known in the fields of gender and development that technology adoption does not depend on gender alone but rather on multiple identifying traits, it may not be well-understood, accepted, or practiced in climate services (Gumucio et al., 2019, 2022). Consequently, our paper helps contribute evidence to an important area that warrants research and better understanding in the context of climate services.

Methods

Study area

Agriculture remains the backbone of Rwanda's economy. The agriculture sector accounts for approximately 31% of the GDP and employs 58% of the labor force (NISR, Labor Force Survey Trends, February 2018). Agriculture is dominated by small-scale, subsistence, rain-fed farming, and mixed-cropping, with a progressive adoption of modern technologies and practices. Agriculture provides most of the employment opportunities for both men and women. Whilst women are more involved in agriculture overall (Gender Monitoring Office, Republic of Rwanda, 2017), men have more control over sale of both small- and large-scale crops. Women's ownership of livestock is increasing although it is still low when compared to men (Gender Monitoring Office, Republic of Rwanda, 2017). Households headed by women are subject to being the most vulnerable to shocks and to be poorer, according to EICV5, 2016/2017. There has been progressive gender-sensitive policymaking in Rwanda since the end of the civil war in the 1990s and this has had some success. For example, legislation exists promoting gender-equal land inheritance, which has helped to promote improved land access for legally married women and improved tenure security for female-headed households (Ali et al., 2014). The succession law (Law no. 22/99 of 12/11/1999) in Rwanda guarantees that married women have the same legal status as men regarding

owning, using, or making decisions about land and property shared by a family (Jones-Casey et al., 2015). Therefore, in Rwanda, women who are household heads have the legal status to make decisions in their households. Despite the significant progress in policy, evidence suggests that the policy changes are promoting gender equality mostly in urban areas (Bigler et al., 2017). In rural communities, patriarchal norms effectively facilitate more lucrative income-generating opportunities for men in comparison with women.

Participants in the study were drawn from fourteen districts of Rwanda which represented a range of different agro-ecologies. Though Rwanda is located within the equatorial belt, its climate is not strictly of the equatorial rainy type. The central and eastern part of the country is generally of semi-arid type owing to its position in the rain shadow of the western highlands. The rainfall characteristics for Rwanda are known to exhibit large temporal and spatial variation due to varied topography and existence of large water bodies near the country. However, two rainy seasons are generally distinguishable, one centered around March–May (MAM season, known as the long rains season) and the other around September–December (SOND season, known as the short rains season).

Implementation process

Over the past 5 years, PICSA has been implemented in Rwanda at a large scale, where more than 112,000 farmers from 30 districts of the country were directly trained on the approach. This was done through the Rwanda Climate Services for Agriculture (RCSA) project that was funded by the United States Agency for International Development (USAID), with the aim to increase resilience of Rwandan farmers to the changing climate and transform the national economy through improved climate risk management. PICSA training was incorporated in the existing national extension program known as Twigire Muhinzi. PICSA is implemented through a cascading process of training of trainers. An initial expert training process was undertaken in 2016, building the capacity of national level trainers from Rwanda Meteorology Agency (Meteo Rwanda), Rwanda Agriculture and Animal Resources Development Board (RAB), International Center for Tropical Agriculture (CIAT) Rwanda and several national and international Non-Governmental Organizations (NGOs). These experts then led 5-day training workshops at district level which targeted Farmer Promoters (FPs). FPs then trained farmers in a series of meetings ahead of both the March-April-May (MAM) and September-October-November-December (SOND) agricultural seasons. Through Twigire Muhinzi extension model, each FP has a group of farmers that they are responsible to train on any intervention in the village. With PICSA training, FPs had to organize a series of training over a couple weeks or so to train farmers in their groups. This had to happen before the season so that farmers could have a chance to implement what they were learning at the training. Because of the busy schedules of farmers, in most of the cases, a training could typically be between 2 and 4 h per day, for 3 days in a week or on consecutive days depending on the groups' arrangements. There was no fixed or similar training days schedule for all the training sessions across all groups. The training content is explained in section 2.3.

Between 2017 and 2019 the approach was progressively scaled to all districts of Rwanda and more than 1500 FPs were trained.

The PICSA approach

PICSA builds on farmers' prior knowledge and experiences and adds new information and participatory planning tools which empower them to consider options, make decisions and plan their strategies. The approach is underpinned by two key principles: (i) the farmer decides and (ii) options by context (Clarkson et al., 2019; Dorward et al., 2015; Staub & Clarkson, 2021). The first principle aims to ensure that the process and facilitators always support farmers in making their own plans and decisions (and does not seek to provide recommendations) as farmers with their knowledge and experience are best placed to do this and are directly affected by the consequences. The second principle acknowledges that each farmer operates in their own unique context (including their access to resources, soil types, aspirations, attitudes to risk) and the PICSA approach helps farmers to identify and focus on opportunities to make decisions regarding resources and activities that are appropriate to their context, that they are interested in and have influence and control over. The process begins well ahead of the agricultural season with individual farmers considering their own resources and farm context using a resource-allocation map and to think about how timing and weather affects them using a seasonal calendar. Farmers then use steps B & C to analyze their local historical rainfall and temperature and the associated probabilities and risks. These activities provide the basis for farmers to identify and explore different crop, livestock and livelihood options using options matrices in steps D & E. Participatory budgets then enable farmers to assess the options that they are most interested in and how they may perform on their farms before comparing the possible outcomes with their existing enterprises. In step G, farmers select options and integrate them into their farming strategies for the coming season. Ahead of the season, farmers are introduced to the seasonal forecast (steps H & I), which they may use to adapt the strategies they have developed, and short-term forecasts (steps J & K) are provided to inform short-term decision-making during the season. The final step (L) involves a process of reflection with agricultural field staff, farmers and researchers.

The evaluation process

The evaluation process was undertaken in two phases, qualitative case studies in four districts in September 2017 and quantitative surveys in ten districts in May 2018 at which point the approach had been implemented in fourteen districts, shown in Figure 1.

Quantitative data were collected through a questionnaire survey that was mainly quantitative but included open-ended qualitative elements. Similar surveys have been used in a number of different countries including Ghana, Haiti, Malawi and Tanzania (Clarkson et al., 2019; Staub & Clarkson, 2021; Steinmuller & Cramer, 2017). The survey was developed to assess whether respondents had been trained in the different steps of PICSA, had understood and used the decision-making tools and climate information in their planning processes. Respondents were asked whether they had made any

Figure 1. Map of Rwanda showing the study sites.

changes in their crop, livestock and/or livelihood enterprises as a result of their engagement with PICSA and what those changes were. The survey also explored farmers' perceptions as to the effects of the changes they had made on their social and economic status and the resilience of their household.

Questionnaires were administered to 492 trained farmers (46% women and 54% men) randomly selected among 53,613 trained farmers across the fourteen districts at the date of the survey. The survey was carried out by trained enumerators using Open Data Kit software following a pilot supervised by the research team. The research/study underwent ethics approval by the Rwanda National Ethics Committee (No.832/RNEC/2016). No payment was offered to respondents for their participation in the survey study.

Qualitative data were collected through a series of case study interviews and participatory activities. The qualitative elements involved 16 respondents who had been purposively sampled from an earlier quantitative survey that is not covered in this paper (Clarkson et al., 2020). Six women and ten men were purposively sampled based on the changes they made after PICSA training—a mixture of those who made changes in crops, livestock, livelihoods and those that made no changes. Farmers were interviewed using open-ended questions to help describe how they responded to the content of PICSA training and the process of any decisions and changes that

they made in their farming enterprises. Participants then compiled participatory budgets and effects diagrams to determine the difference the change had made to inputs (including seed, labor, etc.) and outputs (produce and income) and to understand the farmers' perceptions of the effects of these differences on them and their household.

Data analysis

Quantitative data analysis involved disaggregation by gender, household headship and wealth. With regards to household headship, respondents were asked "what is your relationship to the household head?" and enumerators were trained to consider household headship in the context of who is primarily responsible for decision making regarding resource use. Wealth was measured using the Poverty Probability Index (PPI[2]). For the quantitative analyses, a chi-square test of independence was used to compare observed and expected values (*p*-values were reported at the 5% significance level). In cases where responses were not independent of PPI category or headship, we ran multiple pair-wise comparisons of these variables to determine which pair-wise proportion led to rejection of independence. A series of statements were measured on a five-point Likert scale. The responses "strongly agree" and "agree" were combined into one category and "strongly disagree," "disagree" and "neither agree nor disagree" into a second category. These categories were tested for independence. To compare numbers of changes between different categories we used one-way between groups ANOVA.

Qualitative interviews were conducted in Kinyarwanda, recorded and later transcribed and translated into English. Effects diagrams and participatory budgets were photographed. These data were transferred to MAXQDA 12 for analysis before a thematic analysis was undertaken considering the perspectives of the farmers, the process of change that they undertook, the effects of those changes and the areas of improvement farmers identified.

Results

Socio-demographic characteristics of respondents

Respondents to the survey were from a range of ages (between 21 and 91). Just over half of survey respondents were men (54%) and all these men were heads of their respective households (henceforth referred to as Men Heads). 29% of respondents were women in households headed by men (henceforth referred to as Women Spouses) and 17% of respondents were women household heads (henceforth referred to as Women Heads). The largest proportion of the survey respondents had primary level education (71%), 19% had received no formal education, and the remaining 10% had received secondary level education (though only 1% of the surveyed farmers had completed secondary education). This is similar to but lower than the overall rate of school attendance (87%) according to the most recent integrated household living conditions survey (EICV5 [2016/2017]). The average number of household members (5) was also similar to the national average of 4.4 (EICV5 [2016/17]). Area of land owned

Table 1. Social and economic indicators by gender and headship status.

	Average area of land owned (Hectares)	% Educated to primary level or above (%)	% Educated to secondary level or above (%)	% Likelihood of living on less than the 100% national poverty line (%)
Women Heads ($n = 86$)	0.4	71	8	22
Women Spouses ($n = 143$)	0.4	81	11	26
Men Heads ($n = 263$)	0.6	84	10	22

Table 2. Social and economic indicators by gender, headship status and relative wealth.

	Average land size (hectares)	% Educated to primary level or above (%)	% Educated to secondary level or above (%)	% Likelihood of living on less than the 100% national poverty line (%)
Women Head Least Wealthy ($n = 29$)	0.2	62	3	46
Women Head Medium ($n = 27$)	0.5	74	4	18
Women Head Wealthiest ($n = 30$)	0.4	77	17	3
Women Spouse Least Wealthy ($n = 52$)	0.3	75	2	55
Women Spouse Medium ($n = 43$)	0.4	79	5	17
Women Spouse Wealthiest ($n = 48$)	0.5	90	27	3
Men Head Least Wealthy ($n = 79$)	0.4	80	5	49
Men Head Medium ($n = 88$)	0.7	83	10	17
Men Head Wealthiest ($n = 96$)	0.8	89	14	3

ranged between 0 (landless) and 6 hectares with an average of 0.5 hectares[3]. Social and economic indicators by gender and headship status are presented in Table 1.

Alongside gender and headship status, respondents were categorized by wealth. The nine resultant categories are outlined in Table 2. The table shows that the least wealthy categories have smaller land, less formal education and have a higher likelihood of living on less than the national poverty line. Households headed by men were found to be the wealthiest with the largest land size (average being 0.8 hectares).

Received training, understood training and found it useful in planning and decision-making

The majority of respondents were trained on all of the PICSA tools (see Table 3) though a significantly lower proportion were trained on short-term forecasts ($p = 0.01$). When considering gender and wealth there were no significant differences between the different categories other than the result that a larger proportion of the Women Head Wealthiest received training for Participatory Budgets when compared to the Women Head Medium.

With regards to the understanding of the different tools, the majority of those trained on all tools reported that they understood the training. Overall, smaller

Table 3. Training, understanding and use of PICSA tools by headship status and gender.

	Women Heads			Women Spouses			Men Heads		
	Trained (%)	Understood (%)	Used (%)	Trained (%)	Understood (%)	Used (%)	Trained (%)	Understood (%)	Used (%)
RAM	95	82	76	98	92*	89*	94	92*	88*
HCI	90	68	68	95	80	87*	93	78	82*
P&R	77	56	65	85	75*	82*	82	69*	75
Crops and Varieties	99	99	94	98	96	96	99	99	96
Options matrices	97	94	93	99	94	95	98	97	95
PBs	81	79	74	81	95*	89*	87*	95*	90*
Seasonal forecast	95	93	93	98	96	95	99	99	97
Short term forecast	69	86	76	64	91	89*	71	97* & **	87*

*Significantly higher than Women Heads ($p = 0.01–0.05$).
**Significantly higher than Women Spouses ($p = 0.05$).

proportions of respondents "understood" the session on probability and risks. This could be linked to the capacity of the FPs as the nature of the session makes it more challenging for those who are not confident numerically. Though the majority of those trained understood the tools, there were differences when headship was considered. Smaller proportions of Women Heads agreed that they "understood" RAMs, Probabilities and Risks and Participatory Budgets (Table 3). This may be linked to the fact, as reported in the qualitative case studies (RWPQ14 from the least wealthy category), that Women Heads may experience difficulties to participate and engage with trainings due to their familial responsibilities and stresses. Overall, smaller proportions of respondents "understood" the session on probability and risks. This could be linked to the capacity of the FPs as the nature of the session makes it more challenging for those who are not confident numerically.

Similarly, most of the respondents found all of the different tools "useful in their planning and decision making" processes but there were differences between the headship categories. Smaller proportions of Women Heads agreed that they "used" RAMS, HCI, P&R, PBs and short-term forecasts (Table 3). However, though proportions were lower within the group of Women Heads it is important to note that more than two-thirds of respondents were using the different tools.

Changes that respondents made in their farming practices and livelihoods

Almost all respondents (98%) made changes in their crops, livestock and/or livelihood enterprises as a result of their involvement in the PICSA training. Respondents made between 1 and 8 changes (Mdn = 2). Men Heads made statistically more changes than Women Heads ($p = 0.02$; see Figure 2). The most frequent changes were in crops (96%) followed by livestock (29%) and other livelihoods (5%). Crops tend to be the most important livelihood source for most of the respondents and other evaluations of PICSA (Clarkson et al., 2019, 2020a, 2020b, Staub & Clarkson, 2021; Steinmuller & Cramer, 2017) have shown similar results with a larger proportion of changes made in crops when compared to livestock and other livelihoods, though the proportion of respondents making changes in livelihoods in this survey is low.

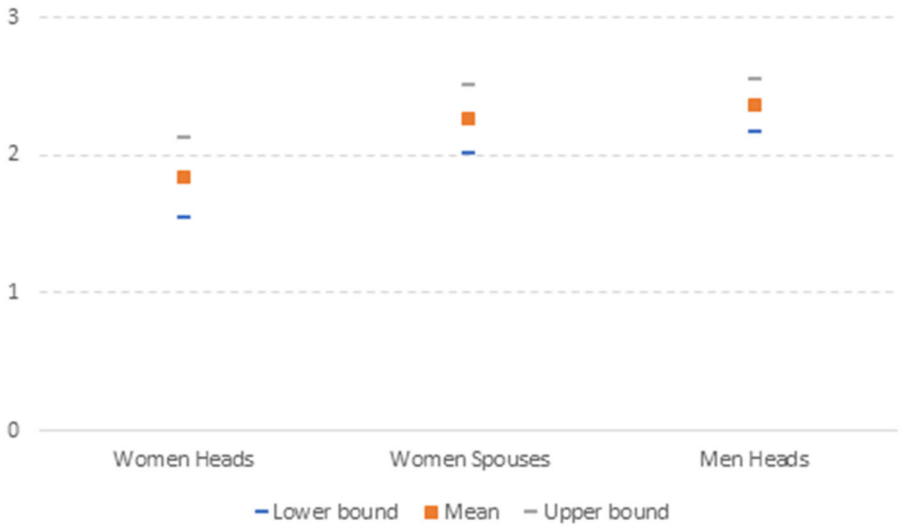

Figure 2. Mean changes made as a result of the training—including confidence bounds (95%) to indicate significance.

Changes in crops were frequent across the different categories of respondents in the survey but larger proportions of Women Spouses (36% [$p = 0.01$]) and Men Heads (29% [$p = 0.03$]) made changes in livestock than Women Heads (17%). When considering wealth, smaller proportions of the least wealthy Men Heads (20%) made changes in livestock when compared to wealthier Men Heads (34% [$p = 0.04$]).

With regards to other livelihoods, quantitative data showed that fewer changes were made. The majority of those that were made were to start new livelihoods and a slightly larger proportion of this was done by wealthier Men Heads and Women Spouses. However, qualitative case studies revealed a number of livelihood changes especially among households headed by women. According to some respondents' opinions, some less wealthy women heads applied PICSA principles in starting non-farm small business. Respondents also highlighted that the training opened their mind for possibilities of creating other sources of income besides agriculture but lack of financial capital remained the major impediment to starting a new business. For example, RWPQ09 (wealth category: Men Head Medium) stated that he "thought to do a developed agri-business project but had financial constraints" and RWPQ10 (Women Spouse Least Wealthy) that

> it was possible to plan for other projects like starting a business, but for me I could not do this because I got injured and went to hospital using my money. But this time I have re-started saving some money …

The most frequent types of changes were either farmers starting a new enterprise or making changes to the management of an enterprise they were already undertaking. Very few respondents changed the scale of an enterprise that they were already undertaking.

New enterprises

A considerable proportion of respondents started to grow either a new variety of a crop (25%) or a new crop (20%) because of the training and the information that they interacted with. Larger proportions of household heads (whether Men Heads [22%; $p = 0.03$] or Women Heads [23%; $p = 0.05$]) started growing a new crop when compared with Women Spouses (13%). There were a wide range of new crops tried (more than 16 different ones across the sample) with Men Heads trying the widest range (10 different types of crops compared to 4 for Women Spouses and 7 for Women Heads). The most frequent new crop to try was maize followed by climbing beans and Irish potatoes. For example, RWPQ13 (Men Head Medium) explained that the training helped him apply the weather forecast to decide to plant a crop based on the length of the season:

> The training was useful as knowing how long the season will last helped me to decide whether I can plant maize, beans, soy or others based on their specific harvesting time. Then based on the weather information I had, I planted beans since they are harvested in short time.

With regards to new varieties, there were no clear differences with regards to gender or wealth and again the most frequent crops to change in were maize, climbing beans and Irish potato.

As well as new crops, respondents reported trying new livestock enterprises. In particular, more than half of those who made a change in livestock ($n = 143$) were starting a new livestock enterprise (53%). Overall, a larger proportion ($p = 0.03$) of Women Spouses (20%) started a new livestock enterprise when compared to Women Heads (9%). There were a range of new livestock that respondents reported and the most frequent were cattle, pigs and goats. Men Heads concentrated more on cattle whilst Women Spouses tried new cattle and pigs.

Changing management of enterprises

The largest proportion of changes made in crops were related to changing of management of existing practices, timing of planting and/or amounts of inputs used in cultivation. Half of respondents changed the way that they managed their land or crops because of the training. A third (35%) of respondents also changed the amount or type of inputs that they use on their farms. Respondents explained that the trainings helped them to be more conscious of the quantity of inputs they use. One farmer (RWPQ05, from the least wealthy category) noted:

> I used to sow using our traditional practices [broadcasting] but after the training I first make rows, put fertiliser and then plant my wheat seeds. We used to plant recklessly by planting 10Kgs where we could plant 5Kgs of seeds now and still have the same harvest … I wasted fertilisers too.

A quarter of respondents (27%) made a change in the planting date (most of those that made a change [97%] decided to plant earlier and as a result of the seasonal forecast). For example, RWPQ02 who falls in the least wealthy category explained how she decided to change her normal planting time, as a result of the PICSA training. For her the tradition was to start her agricultural season with the month of September, regardless of whether there is rain or not, now she waits to make sure the rains have

established before she plants. Women Heads (16%) were less likely to change planting date than either Men Heads (30%; $p = 0.01$) or Women Spouses (28%; $p = 0.03$), perhaps linking to their lower rates of understanding and use of seasonal forecasts (see Table 3).

Just over a third of those that made changes in their livestock enterprises changed the management (just over half of those were in management of cattle). Another type of change in livestock detailed by RWPQ02 during the qualitative study involved borrowing a cow from a neighbor. This farmer belongs to the least wealthy category, and she decided to borrow her neighbor's cow so that she can get manure to increase her crops' productivity. She said:

> The idea of getting a cow to have manure came after training. I understood that I need to use manure and mineral fertilisers in my farm, just to improve productivity but there was no animal at my home by then. So, I decided to ask my friend who owns cows, to give me one so that I can keep it for him and get manure for my farm. That is how I got manure ….

Another Men Head Medium, RWPQ13 was a better-off farmer and had three cows. As a result of the information received about the seasonal forecast from the trainings he attended he decided to sell one of his cows to get more money to invest in other businesses during the bad year/season that was being predicted:

> The resource allocation map influenced my decision on cow keeping. During the training they told us that Kayonza was going to experience drought and as I used to have a small land, I understood that I will not be able to feed my 3 cows. So based on the information, I chose to sell one of my cows. It was obvious that I will not have enough feed for all the three. I thought that in that dry season it would be gainful to buy goats and sell them in the following season.

Limitations/constraints to changes

It is clear from the number and range of changes presented in 3.3 that the training process stimulated farmers to make a range of changes. However, farmers wanted to make more changes than they were able to. Three quarters (75%) of respondents wanted to make more changes in their crop enterprises, almost two-thirds (62%) wanted to make more changes in livestock and just over half (52%) reported that they would like to have made more changes in livelihood. With regards to the constraints to change, the most cited reason was lack of money (67%) followed by lack of land (54%). Larger proportions of Women Heads reported money (79%; $p = 0.02$) and land (63%; $p = 0.03$) as constraints to making changes when compared to Men Heads (64% and 48%). A larger proportion of Women Heads also cited the risk of theft as a constraint to making livestock changes when compared to Men Heads ($p = 0.05$). Within the category of Women Heads, the least wealthy were also more likely to cite size of land as a barrier to making more changes than Women Heads in the medium wealth category ($p = 0.01$).

Figure 3. Economic benefits of training and associated changes by headship status, gender and wealth.

Effects that these decisions and changes are having on farmers and their households

When asked to what extent they agreed with Likert statements on positive effects resulting from their decisions and changes made, on themselves as farmers and on their households, respondents tended to agree with the statements across categories (Women Heads, Women Spouses, Men Heads). When gender and headship were considered the only significant difference was between Men Heads and Women Heads, with a larger proportion of Men Heads agreeing that their household income had increased ($p = 0.02$). However, when wealth was also considered (Figure 3)**.** Women Head Least Wealthy tended to agree the least in comparison to all other sub-categories. A smaller proportion ($p = 0.02$ & 0.03) of Women Head Least Wealthy agreed with statements concerning improved household income (59%; all other than Women Head Medium), improving household food security (76%; all other than Women Spouse Least Wealthy and Men Head Medium), being able to provide for household healthcare (45%), and being able to pay for school fees (48%; all other than Women Head Medium & Women Spouse Least Wealthy). Similarly, one of the qualitative case studies from the least wealthy category (RWPQ14) also highlights that although women may have used PICSA principles in their decisions, they can experience limited positive change due to their poverty-influenced vulnerability.

Considering social status, Men Heads agreed significantly more than Women Heads with statements affirming increased standing within the household ($p = 0.05$) and increased standing within the community ($p = 0.03$), as a result of their decisions and

Figure 4. Perceived social status changes as a result of the training and associated changes made by headship status, gender and wealth.

changes made. Men Heads agreed significantly more than Women Heads with statements affirming perceiving farming as more of a business ($p = 0.03$). It is clear in Figure 4 that the difference is mainly between the Women Head Least Wealthy and the other categories. Fewer Women Head Least Wealthy agreed that their social status within their household (all at least $p = 0.02$) and their community (all at least $p = 0.01$) had improved than all categories other than Women Head Medium and Women Spouse Least Wealthy. With regards to seeing farming as more of a business, fewer Women Head Least Wealthy agreed than all categories other than Women Head Medium (all at least $p = 0.03$).

Considering Women Spouses, those in the medium PPI group agreed most frequently with statements on increased confidence in speaking about farming with fellow farmers (98%) and increased ability to cope with bad years (84%), in comparison to other sub-categories. It is clear from Figure 5 that the least wealthy Women Heads report the lowest agreement with the statements around confidence and ability to cope with bad seasons caused by the weather. There were significant differences (all at least $p = 0.01$) for all comparisons other than with Women Spouse Least Wealthy when confidence was considered and for all except Women Head Wealthiest and Men Head Least Wealthy when confidence in talking to fellow farmers was considered (all at least $p = 0.03$). Whilst the proportion of Women Head Least Wealthy was lower than the other groups it was only significantly different to Women Spouse Medium and Women Spouse Wealthiest (both $p = 0.02$).

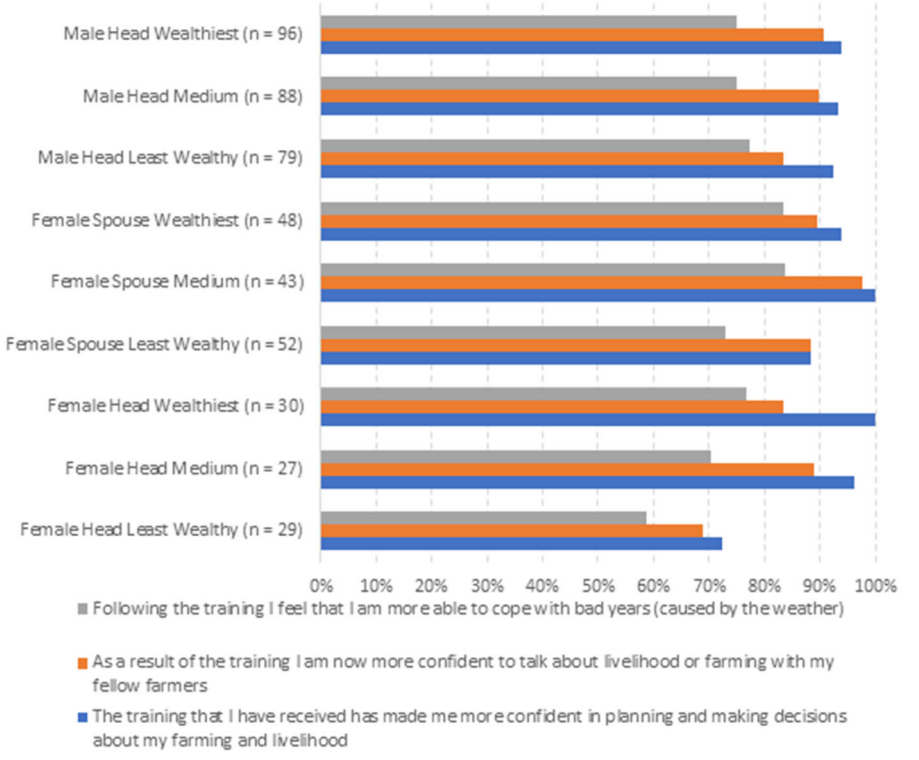

Figure 5. Perceived confidence in farming and decision making by headship status, gender and wealth.

Discussion

The results present a positive response from men and women farmers to the information and tools that they interacted with as part of their training in the PICSA approach. Most respondents received training on all PICSA tools, and it is clear from the results that a large majority of both women and men who received training were able to understand and use the tools and that they actively integrated them into their planning and decision-making processes. While disaggregating results according to gender alone finds very few significant differences, similar to Clarkson et al. (2020a, 2020b), our results show that considering additional socioeconomic variables such as headship and wealth and how they intersect with gender is important for assessing how women and men benefit from climate services interventions.

While most of the respondents found all of the different tools useful in their planning and decision-making processes, fewer Women Heads reported finding RAMS, Historical Climate Information, Probabilities and Risks and Participatory Budgets useful; however, it is important to note that, even within the group of Women Heads more than two-thirds of respondents were using the different tools. Nonetheless, this suggests that the tools aligned with the decision-making needs for fewer Women Heads

than respondents in other categories, or that other constraints such as lack of time or confidence contributed to lower use.

Other results also show differences in the types of changes made, per category of respondent. For instance, larger proportions of household heads (whether men or women) started growing a new crop when compared with Women Spouses. This suggests that women heads are responsible for decisions concerning cultivation of new crops, while women spouses in households headed by men play a less decisive role. Additionally, fewer Women Heads made changes related to livestock in comparison to Women Spouses and Men Heads. This can be related to perceived constraints to make changes, reported by Women Heads; moreover, the results suggest that women heads may be particularly restricted when compared to male heads in this regard: larger proportions of Women Heads reported land and money as constraints to making changes when compared to Men Heads. More Women Heads also cited the risk of theft as a constraint to making livestock changes, in comparison to Men Heads. The results align with findings from other research in agriculture and rural development, which show that women heads can often be challenged to make innovations due to asset poverty (Fisher & Carr, 2015). Livestock production might require additional land, capital and labor (time) that women heads lack; in contrast, women spouses can share in land, assets, and other productive resources controlled by household heads that are men.

In particular, women heads may have less capacity to benefit, in terms of social ascendancy in the household and in the community, from decisions made as a result of PICSA, in comparison to men heads. This may be related to differences in power dynamics among household members of women vs. men headed households; also to differences in social capital and networks between women and men household heads, wherein women household heads might have less access to prestigious social networks that would facilitate social status ascendancy (Manfre & Nordehn, 2013).

Furthermore, women household heads from the least wealthy sub-category might be particularly disadvantaged. Within the category of Women Heads, the least wealthy were more likely to cite size of land as a barrier to making more changes than Women Heads in the medium wealth group. Women Heads in the least wealthy PPI category group tended to agree the least with Likert statements on positive economic effects resulting from their decisions and changes made. The least wealthy Women Heads also reported the lowest agreement with the statements around confidence and ability to cope with bad seasons caused by the weather. Further, within this same category of Homen Heads, the agreement to the same statements increased with wealth, suggesting that women heads with some level of resources (wealthier women heads) were able to see the same effects as heads who are men. Two of the qualitative case studies illustrated how women who are the head of households can face particular limitations in the whole process from training to implementation of what they learn. One woman (RWPQ14) could not complete the training sessions due to other responsibilities while another (RWPQ10) attended but could not follow and understand the PICSA steps due to distractions caused by family problems. Her attempts to implement the new knowledge yielded no effect in her farm. It is very important to

understand the needs of women heads, especially financial constraints and other socio-economic factors that may hinder them from accessing and engaging with training and taking action, as interventions are being designed. In their study, Thobejane and and Nyathi (2018) discussed how female headed households are on the rise in Sub-Saharan Africa and these households face numerous challenges such as low wages, limited opportunities, lack of access to resources such as land, labor, etc. Our findings illustrate that it is not gender alone but the intersection of gender and resources that warrant particular attention.

Wealth may influence benefits from PICSA, for other headship/spousal groups, as well. Among Men Heads, wealthier groups are more prone to make changes in livestock; furthermore, wealthier Men Heads and Women Spouses were more likely to make decisions to start new enterprises in other livelihoods, in comparison to other groups. In general, lack of money, followed by land, were the most cited constraints to make additional changes across the study sample. It is also worth highlighting that the least wealthy groups have smaller land size and less formal education in comparison to the other groups. Further analysis of the importance of wealth and access to resources on farmers' capacity to make different types of changes as a result of PICSA will be important, especially as it concerns livestock production and other nonagricultural livelihoods. As an important consideration for M&E of climate services and for achieving enhanced PICSA impacts, our results suggest that the particular group, women heads least wealthy, might require targeted support in order to benefit from climate services like PICSA as much as other groups.

Conclusions

Although participatory climate services support farmer decision making it is crucial to consider characteristics that may constrain individual's ability to engage with, use and benefit from them. Our findings from Rwanda show that the majority of women and men who were trained on PICSA were able to understand and integrate the PICSA tools into their decision making and experienced positive changes in their livelihoods as a result. Disaggregating our data according to gender alone showed very few significant differences between women and men; however, when considering additional socio-economic variables such as headship and wealth and how they intersect with gender, our results showed significant differences that are important for assessing how different categories of women and men benefit from climate services interventions including PICSA. This paper therefore highlights the importance of applying an analytical lens that considers gender and how it intersects with other identity characteristics and resource access such as headship and wealth when conceptualizing, designing, and evaluating climate services and other interventions.

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Notes

1. In our study, we define headship as holding the status of household head.
2. https://www.povertyindex.org/
3. Farmers' responses were provided in a common unit of measurement used in Rwanda, the "are." Responses were converted to hectares during analysis. An "are" is equivalent to 0.01 hectares.

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