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Dynamics of Gender Preferences for Farm Investment Strategies in Rwanda: A Best-worst Scaling Experiment

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ABSTRACT

Gender gaps affect how women and men access, participate and benefit from the adoption of various farm investment strategies, environmental conservation and sustainable development. Production, conservation, and livelihood strategies are motivated by land and household decision-making dynamics. Understanding gender preference dynamics on investment fills a gap in the gendered division of labor, market participation and agricultural transformation. The study adopted a household survey on 653 male and female respondents in the Burera, Gakenke and Musanze districts of Northern Rwanda. Analysis revealed three farm investment strategies in relation to the relative importance for the agricultural transformation process: the best (>85%), intermediate (between 60% and 85%), and low (<60%). Male and females had varied preferences (positive or negative) for the strategies. Females preferred livelihood strategies that combined on-farm and off-farm sources. The study recommends the adoption of diversified production and livelihood strategies to improve farm investment and market access. Land systems should consider youth inclusion as a dynamic factor in household decision making, women empowerment and agricultural transformation.

1. Introduction

Increased competition for natural resources in developing countries makes farming households adopt new investment strategies related to production, conservation and livelihood, and adapt these strategies to the dynamics of land tenure and household decision making (Mosissa *et al.* 2019). Farm investment strategies are improved methods for using, locating and extracting the resources to comply with current technological advances and economic development. In countries like Rwanda, land and water investments are integrated with each other. As land reserves get used up, water investment become the key to overcoming the land constraint and sourcing agricultural growth for food security and development. Secured land rights and land use conservation provide benefits and incentives that promote investment in farming (Ayamga *et al.* 2016). Further, the success of each investment strategy depends on the farming household's ability to decide how to utilize its livelihood sources derived from farm, off-farm and non-farm income (Bjornlund *et al.* 2019). However, family members' intensity and type of contribution are gender-differentiated but also shaped by the preferences and dynamics in land and household-decision making (Baudin and Hiller 2019).

Gender gaps affect how women and men access, participate, adopt and benefit from environmental conservation and sustainable development. Promoting women and men participation in farm investment and investing in farm technologies is one way of reducing the gap in agricultural productivity (Kiessling *et al.* 2019; Lecoutere and Jassogne 2016). However, the gap does not arise because women are less efficient farmers, but also they experience inequitable access to inputs and technologies and productive decisions (Fisher and Kandiwa 2014). Further, the gender difference in preferences and persistent inequalities to income diversification is attributed to gaps in productivity and differences in human capital (Azmat and Pietrangelo 2014). Nature and nurture explain this difference in terms of competitiveness (or risk-taking) and the role of culture and environment in shaping the differences. For instance, men appear to be more competitive and less risk-averse and hence market-oriented compared to women (Thomas and Hiller 2018).

Farm investment encompasses the adoption of production, conservation and livelihood strategies driven by the dynamics in land tenure/use and household decision-making to accommodate the growing technological development (Bjornlund *et al.* 2019; Baudin and Hiller 2019; Chimhowu 2019). Assessing individual male and female preferences helps to understand appropriate farm investment strategies that would close the gaps and offset the adverse effects of land degradation. Further, it will ensure that the supply of food can meet the growing food demand and help to reduce the share of poor people (Mason-D'Croz *et al.*, 2019).

Recently, farm investment in Rwanda has led to an estimate of 11.7% in the gender productivity gap and 10% (world's average) of fertilizer use (Mukasa and Adeleke 2015). The level of productivity remains far below the world's average, and yield reduction is estimated between 2% and 40% due to soil erosion (Kirui and Mirzabaev 2016). Similarly, fertilizer use is below 50Kg per Ha targeted in the Abuja declaration causing an estimated annual soil loss of 41.5 Tons per Ha for plots with no farm investment practices. This loss is high compared to 18 Tons loss per Ha when some farm practices, including grass strips versus ditches, are combined (Kagabo *et al.*, 2013). The role of gender in production and conservation in closing gender gaps has been widely studied. However, male and female preferences for farm investment strategies and their contribution to the development, management, and governance of natural resources are less understood.

In the volcano highland, over 60% of farm households cultivate less than 0.7Ha, 30% cultivate less than 0.2Ha, and about 3.6 % have greater than one Ha (Bigler *et al.* 2017). Women play an important role in rural labor, but the wage gap is high as they earn about 20% less than men, carry the main bulk of reproductive work (Bigler *et al.* 2018), and are characterized by low market participation (Ingabire *et al.* 2018). On the other hand, limited livelihood options and consistent poor use of agricultural technologies and practices have accelerated soil erosion and a decline in both soil nutrients and productivity. Understanding the dynamics of gender preferences for various strategies of farm investment is important to complete extensive research on gendered agricultural transformation through gendered division of labor and market participation.

This paper contributes to the literature on gendered preferences for investment strategies related to farm production, resource conservation under different livelihood options. The study extends this knowledge by integrating the strategies with land tenure/use dynamics and household decision making. Farm production and conservation strategies, including agricultural inputs and SWC measures, provide insights on combined approaches for sustainable and integrated farming practices (Mosissa 2019). Livelihood strategies are informed by farmers use of diversified sources of household income linking farm production and investment to markets and agricultural transformation (Ingabire *et al.*, 2017). Land consolidation and tenure systems serve as policy enablers for effective and inclusive farm investment and gender empowerment. Previous economic studies assumed that the preferences of the household head determine household-level decisions. Recently, Magnan *et al.* (2020) used experimentally theory-based risk preferences methods and found that men's and women's preferences differently influence farmers' adoption.

The study further adds to the methodology of the BWS experiment to inform technological changes in farmers' choices of best and worst investment technologies. BSW gives extra information about individual preferences compared to other preference methods such as choice experiments (Louviere *et al.,* 2008). As opposed to its wide application in health economics, BWS was employed in social sciences, mainly in labor studies (Kiessling *et al.*, 2019). In agriculture, BWS was used to assess agricultural choice marketing, information use and food consumption (Lamontagne-Godwin *et al.* 2018; Cummins *et al.* 2016).

The remainder of the paper is organized as follows. Section two describes the materials and methods covering the study area and data collection procedure in 2.1, best-worst scaling experimental set up in 2.2. and model specification and data analysis in 2.3. Section three presents the results and discussions. Section four concludes and provides policy implications.

2. Materials and methods

2.1 Study area and data collection procedure

The study of on-farm investment strategies draws data from the volcano highlands of Rwanda. The area covers Burera, Musanze and Gakenke districts (Figure 1). Burera and Musanze are situated along the northwest borders with the Democratic Republic of Congo (DRC) and Uganda. Rain-fed agricultural production serves as the basis for household livelihoods. The area is characterized by a decline in per capita availability of agricultural land per household from 3 Ha to less than 1 Ha (Verdoodt and van Ranst 2016). Continuous agricultural production has made its highly fertile volcanic soils less productive. Irish potato, sweet potato, maize, beans and peas are harvested twice a year. Gakenke is part of the northern highlands zone where activities, including coffee and cassava and animal husbandry, are concentrated.

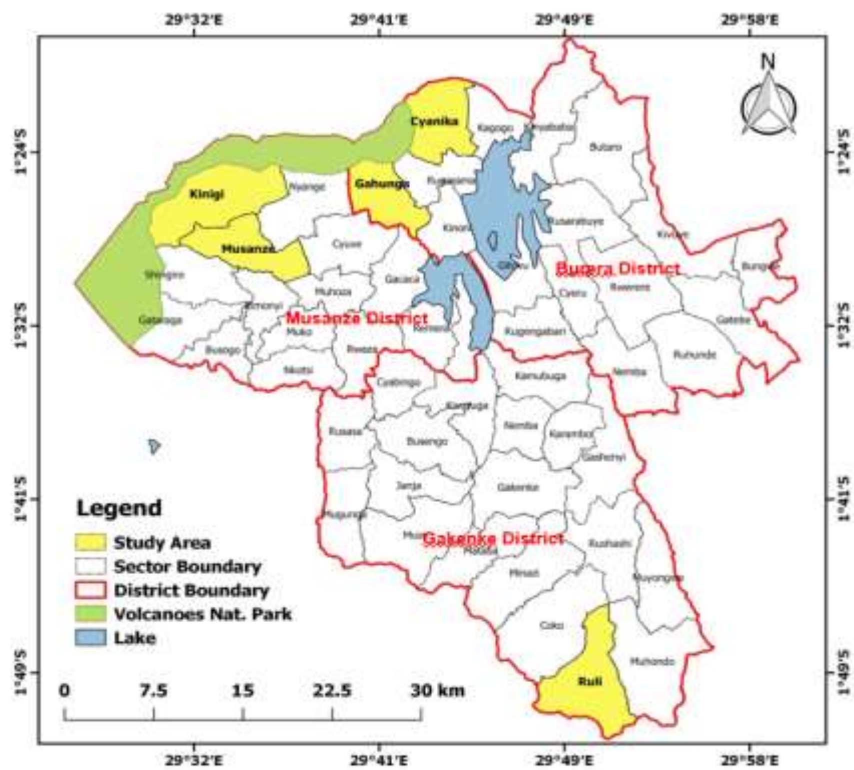

Figure 1. Northern highland administrative boundary and study area
Source: ICPAC Geoportal and Humanitarian Data Exchange (2015)

Over the years, different farm investment practices have been applied to fight soil and water erosion from the volcano park. These include stone fencing, ridges farming and hedgerows contouring with or without agroforestry. Ridge farming uses mulched ridges to retain rainwater from the parking area. These practices increase rainwater infiltration (by up to 10%), crop yields, and water use efficiency and facilitate weed control, but so far, not been effective (Gosar *et al.*, 2010). Combined with Napier grass, the ridges can also boost grain yield, optimize forage conservation and animal performance (Maleko *et al*. 2019). Napier, also considered the highest biomass grass, is well-adapted to smallholder dairy cattle farming because farmers are forced to diversify production on small units. In some areas, banana cultivation (with mulching), French Cameron and eucalyptus are methods of soil erosion grown in rocks that have been flowed together with water streams.

Very few and scattered agroforestry trees have been integrated into farmlands, whereas the trees are fenced in some farms. Commonly known, less labor-intensive practices including trenches, waterways and anti-erosion ditches are adopted at a low rate. Farmers use paid labor to construct these practices, but operation costs are very high.

Water erosion from the volcano is severe. Anti-erosion ditches are used to remove water from production acreage and direct them to waterways. Some nutrients are transported from the farm to natural channel systems or waterways. These are covered with vegetation or surrounded by agroforestry trees to divert or slow down soil runoff and encourage infiltration. It would be of great importance to determine farmer's choices of alternative investment strategies that would lead to integrated and sustainable soil and water conservation measures in the area.

Data was collected between September and November 2019. The population of focus were beneficiaries of the FATE project under the International Center for Tropical Agriculture. Three districts were purposively selected due to the availability of non-traditional agricultural export crops as well as farmers' level of participation in plot-level investment. A multistage sampling procedure was followed to collect data from the three districts, five sectors, 10 cells and 19 villages. A proportionate sampling process was adopted at the village level. 653 female and male decision-makers were randomly selected to participate in interviews using farm investment BWS choice cards (Table 1).

Each respondent was randomly assigned four BWS choice cards defining farm investment options (Figure 1). Using the mother tongue (*Kinyarwanda),* a team of 14 enumerators were trained to perform this task. Enumerators explained to the respondents the purpose of farm investment and the consequences of land degradation if no conservation efforts are made. The respondents were shown farm investment choice cards with different options. Enumerators requested each respondent to evaluate each farm investment option and decide which option they prefer the most and the one they prefer the least. From the remaining two options, respondents were asked to indicate their second-best choice.

Farm investment strategies	**Option A**	**Option B**	**Option C**	**Option D**
Farm consolidated	Yes	No	No	Yes
Soil conservation measures	Ridges farming & Napier grass	Waterways & AED	Hedgerows & Agroforestry	Waterways & AED
Agricultural inputs	Fertilizer & Pesticide	Fertiliser, Pesticide & Water management	Participation in WUAs	Fertiliser use (organic &chemical)
Household decision making	Inclusion of youth	Joint male-female	Male-based	Male-based
Livelihood source	Off-farming	Own account farming	Off-farming	Own account farming
Land tenure rights	Current land tenure	Improved tenure	Current land tenure	Current land tenure
Cost of farm investment	USD 8.4	USD 7.8	USD 7.8	USD 11.2
Which SWC option would you prefer MOST? Which SWC option would you prefer LEAST? Which one of the two remaining SWC option would you prefer MOST?				

Figure 2. Example of farm investment choice card.

2.2. Best worst scaling experimental set-up

The dynamics of gender preferences were determined by using a best-worst scaling (BWS) method. BWS provides ex-ante insights on alternative ways of farm investment. A multi-profile case was adapted whereby respondents repeatedly chose between farm investment attribute- levels in a choice set. The design of the BWS experiment was based on literature to identify farm investment attributes and levels. Both focus group discussions (FGDs) and key informants' interviews (KIIs) were used to complement and refine attribute-levels. A pretest was carried out to assess the adaptability of each attribute-level to local conditions. In total, seven household farm investment strategies/ attributes entered the experimental design (see Table 2). Some of these farm strategies were related to production (such as intensification of crops under farm consolidation and use of agricultural inputs), conservation strategies that involve the adoption of various SWC measures; and livelihood strategies that entail the use of farm and/or off-farm sources for farm investment and household income. Other attributes involved adaptation to the dynamics covering issues of land tenure and land-use patterns, and household decision-making process and accommodate gender empowerment.

Table 2. Farm investment attributes and levels

Farm investment strategies	Attribute levels	Notation
	No	NLC
Farm consolidation	Yes	YLC
	Ridges farming & Napier grass	SRC
	Hedgerows & Agroforestry	SHGA
Soil conservation measures	Waterways & AED	SWAED
	Fertilizer use (organic &chemical)	UFOC
	Fertilizer & Pesticide	UFEP
	Fertilizer, Pesticide & Water management	UFEPWA
Agricultural inputs	Participation in WUAs	ULWUA
	Male-based	IMAB
	Joint male-female	IJMAF
Household decision making	Inclusion of youth	IIYOU
	Own account farming	LOAF
Livelihood sources	Off-farming	LOFFA
	Current land tenure	TCUL
Land tenure rights	Improved tenure	TIMPLA
Cost of farm investment	USD 4.5; USD 7.8; USD 8.4; and USD 11.2	COFI

**Note that the first letter of the attribute-level notation indicates the first letter of the name of the attributes. It is followed by abbreviated names of levels.

The experimental design combined seven farm investment strategies (K= 7) and their levels. These had two, three or four levels (L = 2,3,4). These provided a total number of scenarios given by LK. This combination helped model individual-level choices in non-trivial cases involving three, four or five choice options per choice set and six to 10 attributes varying over two or four levels (Louviere *et al.*, 2008).

Practically, such a design is not feasible for analysis, and therefore a fractional factorial design was adopted. In such a case, this design provides the best estimates. The orthogonal main-effect design plan (OMEPs) was employed to generate farm investment choice sets using IBM SPSS statistics. OMEP was an appropriate choice for farm attribute-level even if unequal level replication occurs for more than one attribute (Street and Knox 2012). In total, 64 combinations of farm investment attributes and levels were created and grouped in 16 choice sets (with four alternatives each), eight profiles, and seven attributes with 17 levels. The attribute-level combination into a full factorial design could yield 1152 maximum BWS choices.

2.3. Model specification and data analysis

The theoretical foundation of the best-worst scaling experiment provided by Marley and Louviere (2005) was used. BWS method is centred on an ordering task that requires survey respondents to make a selection from a collection of items. It consisted of choosing the best (most preferred) and worst (least preferred) items in a series of blocks that contained three or more items. Best-worst scaling is rooted in Random Utility Theory (RUT) by McFadden (1974). RUT assumes that decision-makers maximize their utility by choosing their favourite alternative among a set of alternatives. Compared to the choice experiment, the BWS method gives extra information about individual preference and takes advantage of the human propensity to best identify extreme objects (Louviere *et al.*, 2008).

The potential best-worst choices for farm investment were defined as a pair. The error term was assumed to follow the Gumbel distribution for every pair of the best-worst choice combination. The random utility theory for BWS was presented through the maxdiff model (Equation 1).

$$P_{BW}(ii'/X) = \exp(\mu(\sum_{k=1}^{n}\left(\beta_i X_{ki} - \beta_{i'} X_{ki'}\right)) / \sum_{j' \neq j} j, j' \in M \exp(\mu(\sum_{k=1}^{n}\left(\beta_j X_{kj} - \beta_j X_{kj'}\right) \qquad 1$$

where X_{ki} is the attribute level in the profile that is chosen as the potential best option, $X_{ki'}$ is chosen as the potential attribute with the worst option; μ represents a parameter that determines the scale of the utilities. Parameter vectors β_i are associated with X_{ki}, and $\beta_{i'}$ are parameter vectors associated with $X_{ki'}$.

Based on the above equation, the maxdiff was then presented by the popular MNL-based model in Equation 2. MNL assumes that the utility associated with the best option is the negative of utility associated with the choice of the worst option (Flynn *et al.*, 2007).

$$FHI\begin{cases}0\\1\end{cases} = (\beta_i NLC - \beta_{i'} NLC) + (\beta_i SRC - \beta_{i'} SRC) + (\beta_i SHGA - \beta_{i'} SHGA) + (\beta_i SWAED - \beta_{i'} SWAED) + (\beta_i UFOC - \beta_{i'} UFOC) + (\beta_i UFEP - \beta_{i'} UFEP) + (\beta_i UFEPWA - \beta_{i'} UFEPWA) + (\beta_i ULWUA - \beta_{i'} ULWUA) + (\beta_i IMAB - \beta_{i'} IMAB) + (\beta_i IJMAF - \beta_{i'} IJMAF) + (\beta_i IIYOU - \beta_{i'} IIYOU) + (\beta_i LOAF - \beta_{i'} LOAF) + (\beta_i LOFFA - \beta_{i'} LOFFA) + (\beta_i TCUL - \beta_{i'} TCUL) + (\beta_i TIMPLA - \beta_{i'} TIMPLA) + (\beta_i COFI - \beta_{i'} COFI) + \mu \quad (2)$$

Econometric analysis for the maxdiff model determined the likelihood that farm investment attribute levels could be identified as most important or least important. The dual coding, with best=1 and best=0, was used to estimate the MNL model with the maxdiff (Mühlbacher *et al.*, 2016). Best was equal to 1 if farm investment attribute-level was chosen as the most important, and best equals 0 otherwise. Alternatively, worst was equal to 1 if the attribute- level was chosen as the least important and worst equals 0 otherwise. The dummy-variable coding was set by considering the "farm consolidated (YLC) reference attribute. The next step was to subtract the important measurement for the YLC base value from all other 17 attribute values. This provided individual-specific measures of importance for each farm investment attribute-level. However, the results by BWS data and MNL model assume homogeneity across respondents and have an asymmetric heterogeneity structure. MNL model assumes that farmers have heterogeneity tastes for unobserved attributes but common tastes for observed farm investment attributes (Fiebig *et al.* 2010). Therefore, BSW data could not allow further estimation using models such as mixed or heterogeneous logit, random parameter or latent class to allow heterogeneity in choice parameters.

Descriptive analysis was performed based on count analysis and the method of relative attributes importance. Counting scores (disaggregated by gender) were used to determine farm investment attribute levels (see Figure 2). The probability that a respondent chooses a pair in a particular BWS choice set that maximizes the difference between the "worst-attribute" and the "best-attribute" was proportional to the difference between the 'best' and 'worst' item on the scale of importance (Flynn *et al.* 2007).

The method of count analysis fails to ensure comparability of results and does not provide any conclusions regarding the relative economic importance of attributes. The relative attribute importance used to determine farm investment strategies was given by the square root of best-worst scores (Figure 3). The most important attribute was "**waterways and anti-erosion ditches (SWAED)**". This attribute had the highest value of the best-worst square root. SWAED was assigned the highest index with an interval scale of 100 and therefore scaled by a factor to become 100%. All other attributes were evaluated and compared relative to the 100% scale of SWAED (as a reference attribute) and by their relative square root (best-worst) ratio.

3. Results and discussions

3.*1. Count analysis of the importance of farm investment strategies*

Counting scores highlighted in Figure 2 represent farmer's utility scores of best and worst farm investment attributes. The highest best scores and second-best scores were placed on livelihood sources, SWC measures and household decision making attributes. Under livelihood, participation in own account farming (LOAF) recorded higher scores than participation in off-farm activities. This implies that smallholders perceived farming as their best economic empowerment option. Small farm commercialization is essential to increase household income and better access to diversified and nutritious food. However, rural farm households do not only rely on farm income to sustain their livelihoods, but they can diversify their income source into the nonfarm sector (Alobo 2019). These results suggest production strategies designed to empower both males and females to respond to markets and investment in yield increasing technology. This could be enhanced by improving smallholders' farm sector performance through the provision of inputs, functional institutions, and markets.

Regarding the attribute related to SWC measures, the highest scores were observed for "waterways & anti-erosion ditches (SWAED)". SWAED was followed by Hedgerows & agroforestry (SHGA) and ridge farming (SRC), respectively. Preferences for SWAED may indicate smallholders' consciousness about soil and water erosion effects on land degradation. This also implies that farmers understand the complementary roles of SWAED to farm productivity. SWAED reduces water runoff volume and velocity and directs water to large water streams. For household decision making, the inclusion of youth (IIYOU) had higher scores than joint male-female or sole male decisions. The results suggest that incorporating the youth in land ownership and productive decisions is an important aspect of participatory household decisions. This could lead to increased cooperation of spouses. It could also reduce information and bargaining power asymmetries in smallholder farming households (Lecoutere and Jassogne 2016).

Respondents showed modest preferences for attributes related to farm consolidation and land tenure rights. Higher scores for non-participation than participation in land consolidation were observed. This could be linked to farmers' misperception about the inability of the monocropping system under land consolidation to meet food security and diversification. Chigbu *et al.* (2019) argued that land consolidation undermined the livelihood of subsistence farmers and their knowledge about food usage. The results on land tenure rights indicated that males and females had high best scores for improving the land tenure system (TIMPLA). This is an indication that involving access to land by young men and women is key to innovation and creativity. Consequently, it helps to develop new, environmentally responsible and highly productive farming practices (White 2015).

Agricultural inputs play a crucial role in ensuring stable and high crop yields. On-farm use has remained extremely low compared to the average in SSA and in all developing countries. Hence, increasing the use of agricultural inputs on food crops is still an elusive goal in Rwanda. This attribute recorded the lowest best scores but the highest worst scores. The least preferences for the attribute "agricultural inputs" vis a vis other attributes may be attributed to a negative perception of the overuse of chemicals and its implications for food safety and agricultural sustainability (Liu *et al.* 2020).

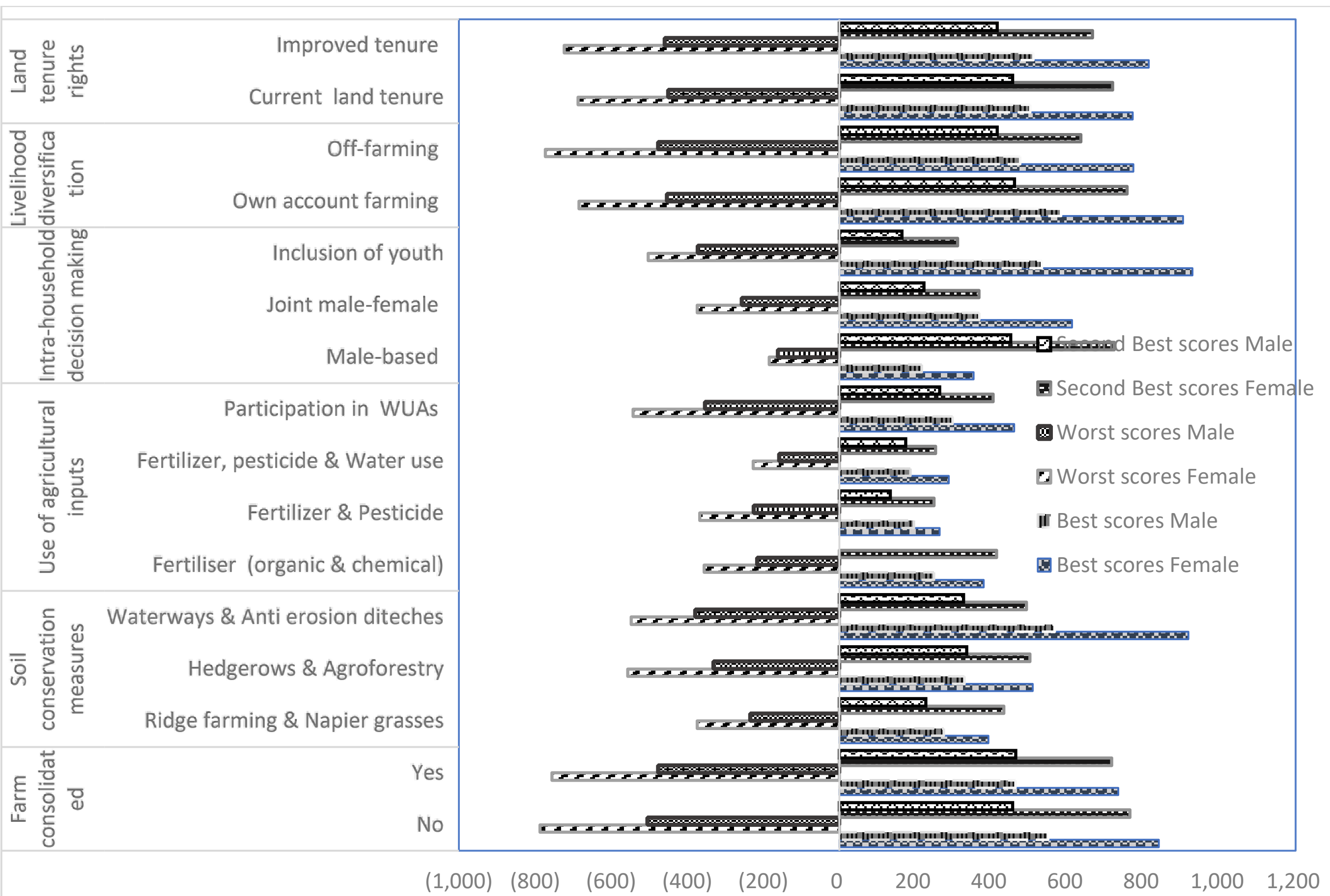

Figure 3: Count analysis of best-worst scores disaggregated by gender

The highest scores were observed for participation in WUAs, followed by the use of fertilizers in combination with manure; and then with pesticides. The results indicate that smallholders are concerned with water resources management for the sustainable production of crops. Preferences for fertilizers combined with manure over others demonstrate farmers' awareness of the use of organic farming for food safety.

3.2. Economic importance of household farm investment strategies

Both average and relative importance of farm investment attributes are shown in Table 3. The study identified that "**SWAED**" had the highest relative importance of 100%. SWAED was followed by attribute-levels with 85% to 92% relative importance. These were: own account farming (LOAF), the inclusion of youth decisions (IIYOU), land consolidation (YLC) and improvement in land tenure system (TIMPLA)". The relative importance values are considered as probabilities that farmers choose these attributes as most important.

Table 3. Raking farm investment attributes

SWC attributes	(Best-Worst) Score	Av. (Best-Worst)	Raking Av. (B-W)	Square root (Best-Worst)	Relative importance (%)	Ranking
Inclusion of youth decisions	833	1.28	1	1.11	90.49	3
Joint male-female decisions	635	0.97	2	0.79	63.08	10
Own account farming	350	0.27	3	1.10	91.93	2
Waterways & AED	155	0.23	4	1.11	100.00	1
Fertilizer, pesticide & Water use	91	0.14	5	0.58	38.42	15
Improved tenure system	142	0.11	6	1.06	85.33	5
Current tenure	137	0.10	7	1.03	81.21	6
Ridge farming (with Napier)	60	0.09	8	0.62	51.49	12
Fertiliser (organic & chemical)	58	0.09	9	0.63	46.09	14
Farm consolidated	98	0.07	10	1.06	88.96	4
Off-farming	-18	(0.02)	11	0.99	80.26	7
No-farm consolidated	-34	(0.02)	12	1.00	77.98	8
Hedgerows & Agroforestry	-49	(0.07)	13	0.85	63.90	9
Fertilizer & Pesticide	-132	(0.20)	14	0.42	38.42	16
Participation in WUAs	-137	(0.21)	15	0.68	54.42	11
Male-based	-304	(0.23)	16	0.57	48.69	13

With reference to SWAED, the probability of choosing "land tenure (TCUL), off-farm businesses (LOFFA), nonfarm consolidation (NLC), hedgerows and agroforestry (SHGA), and joint male-female decisions (IJMAF) was between 60% and 85%. The probability of choosing the rest of the attributes was less than 60%, implying that SWAED was about twice important as these attributes.

Build on this approach; we classified these choice probabilities into three household farm investment strategies (best, moderate, low or basic). These investment strategies reflect the relative economic importance of farm attributes as measured by the marginal rate of substitution (Mühlbacher *et al.*, 2016). The high farm investment strategy with relative importance above 85% indicates that investment is comparatively and highly viable for investment. The package of farm attribute-levels under this investment strategy include SWAED, LOAF, IIYOU, YLC and TIMPLA. The strategy also puts emphasis on intensification and household decision making to explain the linkages between farm investment technologies, land consolidation and market participation. Thus, smallholders willing to invest in a farm using this strategy can maximize production and contribute to environmental sustainability.

The moderate farm investment strategy covers attribute levels with 60% to 85% relative importance. Attributes in this category include TCUL, LOFFA, NLC, SHGA and IJMAF. This farm investment strategy could be well linked with agricultural transformation processes since it involves changing farmers' livelihood and engaging themselves in off-farm businesses and farm enterprises and joint (male-female) decision making by members of the farm household.

The basic investment strategy comprises attribute-levels with relative importance below 60%, almost half important as the best investment strategy. This strategy comprises the following attributes: ULWUA, SRC, IMAB, UFOC, UFEP and UFEPWA. It is dominated by traditional subsistence farming involving a unitary household model of decision making. The strategy reflects smallholders' willingness to continue current farming. However, it has no consideration of gendered roles. It puts emphasis on participation in farm investment by collectively managing water resources, as well as the use of fertilizers (both organic and inorganic).

3.2. Econometric estimation of gender preferences for farm investment attributes

Econometric results of best-worst scaling with a maximum difference and multinomial logit (MNL) are depicted in Table 4. Findings determine individual and combined gender preferences on the basis of the reference attribute-level "farm consolidation (YLC)". The coefficients for each attribute-level were estimated relative to YLC. Relative preferences for these other attributes were compared to the measure of strength and direction of farm consolidation. The choice of YLC as a reference attribute is based on its role in crop intensification. The assumption is that farm consolidation creates market integration and economies of scale to increase profitability and promote household wellbeing (Cioffo *et al.*, 2016). Generally, the results revealed that males and females had joint negative preferences for non-consolidation relative to farm consolidation. The overall fitness of the model was good, as indicated by the Log-likelihood ratio, the test of chi-square and the p-value of the model. The values of Log-likelihood (-313.13886) and qui-square test (Prob > chi2 = 0.0000) were significant at 1%. This is an indication that the overall fitness of the MNL model was highly good.

Table 4. Gender dynamics in preferences for farm investment strategies

Farm strategy preferences	**Female (n=400)**	**Male (n=294)**	**Overall male-female (n=694)**
Farm consolidated	(base outcome)		
No-farm consolidated	-6.05*** (0.78)	-13.29*** (4.14)	-2.99*** (0.31)
Ridge farming (with Napier)	2.40*** (0.50)	5.41*** (2.19)	0.72*** (0.24)
Hedgerows & Agroforestry	1.84*** (0.50)	3.71** (1.77)	0.39* (0.23)
Waterways & AED	2.11*** (0.46)	4.30** (1.96)	0.48** (0.24)
Fertiliser (organic & chemical)	1.04*** (0.29)	3.34** (1.38)	0.7*** (0.22)
Fertilizer & Pesticide	0.89*** (0.28)	2.72*** (1.02)	0.08 (0.28)
Fertiliser, pesticide & water use	0.46* (0.26)	1.10 (0.75)	-0.11 (0.23)
Participation in WUAs	0.69*** (0.26)	2.09*** (0.80)	-0.24 (0.25)
Male-based decisions	0.02 (0.15)	-0.14 (0.37)	-0.46* (0.25)
Joint male-female decisions	-0.68*** (0.18)	-1.74*** (0.67)	-0.4* (0.21)
Inclusion of youth decisions	-0.02 (0.13)	0.13 (0.36)	-0.51** (0.23)
Own account farming	1.63*** (0.47)	1.56 (1.10)	0.87*** (0.25)
Off-farming	0.76* (0.44)	-0.88 (1.27)	0.63*** (0.26)
Current tenure	1.34*** (0.40)	2.86** (1.33)	0.76*** (0.25)
Improved tenure system	1.15*** (0.39)	2.96** (1.35)	0.73*** (0.25)
Cost of farm investment	0.0004** (0.00)	0.0004 (0.00)	0.00019* (0.00)
_cons	- 4.17** (2.13)	-5.72 (5.10)	-4.04*** (0.97)
Log likelihood = -313.13886			
LR chi2(17) = 245.14			
Prob > chi2 = 0.0000			
Pseudo R2 = 0.2813			

Note: *** p<0.001; **p<0.01; *p<0.1, implies 1%, 5% and 10% level of significance respectively.
Standard errors are in brackets.

Findings show that there were joint positive and individual gender preferences for all SWC measures. Ridge farming was highly preferred as common farming and SWC practice. It was followed by waterways & anti-erosion ditches, and then hedgerows & agroforestry. Appropriate application of these combined practices and micro-catchment techniques improves crop yield and soil water content. These results highlight the importance of the integrated use of innovative products and conservation measures to agricultural productivity. Consistently with Islam *et al.*(2017), integration of SWC practices improve crop productivity, plant height and yield performance on a sustainable basis. These combined approaches can also reduce soil loss, maintain vegetative soil cover and replenish soil organic matter.

Agricultural inputs have positive effects in maintaining the soil properties. In terms of pests and disease control, these inputs contribute to enhanced plant health, increased productivity and improved crop storage. Overall, there were joint gender preferences for the use of organic and inorganic fertilizers combined. The high preferences over other inputs could be associated with smallholders' perception of economic, health or environmental costs of chemicals. Thus, the integrated application of both organic and inorganic sources of nutrients could efficiently enhance the fertility of the soil, thereby achieving maximum yield (Liu *et al.* 2020). Individual male and female preferences were observed for the use of fertilizers and pesticides. However, Sebatta *et al.* (2019) argued that low preferences could be due to their high costs in addition to the negative impacts they have on the environment and human health. Only females preferred to combine water with fertilizers and pesticides on the farm. This is because maybe, men are not concerned with water shortage in areas where rainfall is believed to be abundant. The results indicate that women would choose to participate in water resources and integrated nutrient management as the best approach for enhancing soil fertility and then contribute to food production and resources conservation.

Participatory household decisions, regarded as a dynamic process, has been positively linked with gender gaps in sustainable intensification and productivity. All farmers (male and female) have shown dissatisfaction or their negative preferences on the current household decision making process. Overall, "joint male-female" or include the youth in decision making was highly significant for all the respondents showed that there are both joint and individual negative preferences for household decision making. The negative preferences suggest that accommodating youth and joint farm investment decisions in a household is still at the initial stage. The results also deviate from the conceptualization that farm households should act as collection action institutions that make interactive decisions about investment within the household (Lecoutere and Jassogne 2016). This could be translated into a lack of bargaining power within households. Also, there could be a lack of awareness in the community on issues of participatory household decisions.

Diversification of livelihood sources reflects the need for alternative income to supplement farming households. Overall, both males and females prefer to diversify household sources into farming and off-farm activities to finance farm investment. This reflects male and female's awareness of the importance of off-farm employment to household income. According to Rashidin *et al.* (2020) and Melketo *et al.* 2020, a considerable share of off-farm employment to household farm income contributes to increased farm investment and agricultural productivity. Individual female preferences reflect their desire to engage in a variety of off-farm activities because they have been left behind in farming. These results signal that a woman could be provided with training and incentives for them to participate in economically viable ventures and become economically empowered.

Secure land rights and understanding of land issues in Rwanda is linked to various incentive mechanisms aimed to improve farm productivity and promote specialization in farming (Alobo 2019). The study found that both males and females prefer to improve the current land tenure. Improving land tenure is consistent with the principles of sustainable development and agricultural transformation since it recognizes the centrality of land to development and promotes tenure rights and equitable access to land, fisheries and forests. Women showed high preferences for the current land tenure, whereas men highlighted the need for an improved land tenure system. The results may also suggest that inadequacy for land use rights and decision-making authority of women over land may compromise participation efforts in consolidation (Hughes and Kaiser 2017). Male, differently from females, could be conscious and aware of dynamics in land laws that would provide equal rights to land ownership for young women and men.

4. Conclusion and policy implications

The study applied the BWS experiment to analyze dynamics in male and female preferences for farm investment strategies at the household level. Seven attributes involving production, conservation and livelihood strategies, as well as aspects of land and household decision-making dynamics, provided useful insights on the agricultural transformation process. The results indicated that strategies leading to livelihood diversification, resources conservation with SWC measures, and household decision-making process were highly preferred since they scored the highest scores. The study revealed that agricultural transformation could be driven by three household farm investment strategies by stating their desire to shift from the lowest to the highest investment strategy. This behaviour reflects male and female willingness to move away from current subsistence farming, which does not consider gendered roles. The results also put emphasis on intensification and environmental protection to explain the linkages between farm investment technologies and market participation. Further, it focuses on and household decisions and livelihood diversification as key drivers of gender empowerment and agricultural transformation. A change in livelihood is seen under consideration of small farm commercialization as the best economic empowerment option. Hence, farmers could be strengthened by diversifying their income sources into the nonfarm sector. The results reveal that land tenure and land consolidation can promote specialization in farming and result in market linkages and economies of scale. Also, youth participation in household decisions could be linked to investment, increased cooperation of spouses and reduced information asymmetries. Male and female dissatisfaction due to negative preferences for joint or youth inclusion in household decisions could be attributed to the lack of collective action in a household that would make decisions about farm investment interactive. The study also revealed the lack of

heterogeneity tastes for observed farm attributes. Further preference studies could apply advanced models (mixed logit or random parameter logit) to explore heterogeneity for farm investment strategies.
The overall results of the study indicated that all household farm attributes play a critical role in defining farm investment strategies. Thus, key policy implications should focus on empowering both males and females to engage in additional ventures to diversify livelihood sources of income. Participatory household decisions could be placed at the center to improve women empowerment adequacy to close both yield and gender gaps in productivity. Policymakers should design and implement production and /or conservation strategies for integrated nutrient and water resources management. Agricultural transformation processes would require the designed production strategies to respond to markets and link farm investment with available technology development. Finally, land consolidation and land tenure should provide incentive mechanisms that promote specialization in farming, strengthen market linkages and enhance economies of scale.

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