Agricultural Water Management 213 (2019) 135–145

Contents lists available at ScienceDirect

Agricultural Water Management

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

The dynamics of the relationship between household decision-making and farm household income in small-scale irrigation schemes in southern Africa

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ARTICLE INFO

Keywords:
Irrigation
Southern Africa
Livelihood strategies
Household income
Gender balance in decision-making

ABSTRACT

Irrigation has been promoted as a strategy to reduce poverty and improve livelihoods in southern Africa. Households' livelihood strategies within small-scale irrigation schemes have become increasingly complex and diversified. Strategies consist of farm income from rain-fed and irrigated cropping as well as livestock and an increasing dependence on off-farm income. The success of these strategies depends on the household's ability to make decisions about how to utilize its' financial, labour, land and water resources. This study explores the dynamics of decision-making in households on-farm household income within six small-scale irrigation schemes, across three southern African countries. Household survey data (n = 402) was analyzed using ordered probit and ordinary least squares regression. Focus group discussions and field observations provided qualitative data on decision-making in the six schemes. We found strong support for the notion that decision-making dynamics strongly influence total household income. Households make trade-offs between irrigation, dryland, livestock and off-farm work when they allocate their labour resources to maximize household income; as opposed to maximizing the income from any individual component of their livelihood strategy, such as irrigation. Combined with the impact of the small plot size of irrigated land, this is likely to result in sub-optimal benefits from expensive investments in irrigation infrastructure. Policy-makers must consider this when developing and implementing new policies.

1. Introduction

Increasing the productivity and profitability of small-scale irrigation systems in developing countries is critical to improve food security and well-being of small-scale irrigators and their communities. In the past few decades in sub-Saharan Africa (SSA), agriculture has been a contributor to reducing poverty (Davis et al., 2017). In rural areas, livelihood diversification is increasingly dependent on off-farm activities, and has been associated with increased household income and poverty alleviation (Davis et al., 2017; Ellis, 2000; Ellis and Allison, 2004; Manero, 2016).

Farming households and their decision-making are central to the development challenge of alleviating rural poverty in developing countries (Booysen et al., 2013). On a daily basis, households have to make decisions about the allocation of their labour, land, water and capital resources between the different income earning activities. Decisions are often taken by different household members, who may not all be present on-farm. Decisions might be sub-optimal for a particular income earning activity, and therefore for the family member undertaking it, but optimal for overall household well-being. Income diversification and the balance of decision-making across household members constitute what we define as the "dynamics of household decision-making".

Within small-scale irrigation schemes, income diversification includes rain-fed cropping, irrigation, livestock, and off-farm[1] activities. Off-farm activities vary from being seasonal to a degree of permanency

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[1] Off-farm activities are not related to household farm operations. They include working for other farmers or businesses within the local community, working away or running a small business.

https://doi.org/10.1016/j.agwat.2018.10.002
Received 7 May 2018; Received in revised form 2 October 2018; Accepted 4 October 2018

(Ellis and Allison, 2004). Consequently, many men between the ages of 30–60 are absent from irrigation schemes (Cousins, 2013), and women (approximately 50% of the agricultural labour force) are often the principal farmers (Bryceson, 2002; Food and Agriculture Organization of the United Nations, 2011a). Women's involvement in decision-making for various farm and household activities has been studied in the context of property ownership; gendered management systems; innovation and food security; women's empowerment; and landscape management (Doss et al., 2014; Meinzen-Dick et al., 2012; Mutenje et al., 2016; Peterman et al., 2015; Pierce Colfer et al., 2015).

Whilst different crops have been considered in these studies, there is no explicit differentiation between irrigated and rainfed production and whether the decision-making dynamics are associated with irrigation households. There is also a gap in how this dynamic influences overall household income, and the differing roles of female decision-making in irrigation schemes in Africa.

This paper fills this gap using on-farm surveys from six small-scale irrigation schemes in southern Africa, and addresses three research questions: i) are traditional decision-making norms reflected in contemporary irrigator households in southern Africa; ii) what influences the gender balance of household decision-making; and iii) how do decision-making dynamics influence household income? This knowledge is important, especially as irrigation is presented as one way to improve livelihoods and economic development in rural Africa (Xie et al., 2014). Participation in decision-making (both intra-household and within irrigation communities and management) is associated with access to knowledge and empowerment, and has the potential to change gender norms (Meinzen-Dick et al., 2011; Stern et al., 2016; van Koppen and Hussain, 2007).

The paper first discusses the literature on livelihood strategies and farm household decision-making dynamics. Section three provides background on the six irrigation schemes (location and demographics); and outlines the collection of data using household surveys and focus group discussions, the construction of a decision index, and the modelling of influences. Section four presents the results and discusses: 1) the overall decision-making index for each country and for four production types (rainfed, irrigated crops, cattle, small stock); 2) the influences on the decision-making index (overall and by production type); 3) the influence of the decision-making index on income; and 4) insights from the focus group discussions.

2. Livelihood strategies and the decision-making dynamics of farm households

2.1. Livelihood strategies and income diversification

Household income diversification is widespread—regardless of location, farm size or wealth (Bryceson, 2002; Ellis, 2000). In contrast to other regions, the largest share of household income in Africa is derived from agriculture: approximately two-thirds for 92% of households (Davis et al., 2017). Off-farm income represents about one third of earnings for 70% of SSA households, with few households relying on remittances (Davis et al., 2017). In particular, off-farm income is beneficial for reducing reliance on natural resources and alleviating poverty, and increasingly important for driving growth in yields (Ellis and Allison, 2004; Proctor and Lucchesi, 2012). Whilst agricultural income is the dominant regional income source, the proportion varies significantly across countries and irrigation schemes. For example, agricultural income accounted for 73%, 49% and 27% of household income within six schemes in Tanzania, Zimbabwe and Mozambique, respectively (Manero, 2016). On the other hand, a study of smallholders in KwaZulu-Natal found farming contributed to 14% of household income (Sinyolo et al., 2016). Findings by Manero (2016) suggested that agriculture-only households have lower incomes, with comparatively higher income households better able to diversify into off-farm income earning activities (Ellis and Allison, 2004).

As more household members take up off-farm activities, the traditional divisions of labour, economic rights and roles dissolve (Bryceson, 2002). For example, young people have mixed livelihoods that include off-farm work, with a greater proportion of 15–24 year olds working off-farm compared to other age groups (Zuo et al., 2018). Additionally, whilst it has been argued that off-farm work is more prevalent for men, a recent study shows similar proportions of young men and women working off-farm (Bryceson, 2002; Zuo et al., 2018). The out-migration of males and feminization of agriculture in SSA, has resulted in increased roles and responsibilities for women (Bryceson, 2002; Food and Agriculture Organization of the United Nations, 2011b; Lastarria-Cornhiel, 2006). Despite this change, women left on the farm may have little decision-making power (Ellis and Allison, 2004); however, this may be connected to their reluctance to report their decision-making power and also whether they are *de facto* or *de jure* households (Lastarria-Cornhiel, 2006).

2.2. Patterns in management and decision-making

The household is the basic unit of production and makes many critical farming decisions (de Sherbinin et al., 2008). Unitary and collective models are used in farming household research: however, both approaches oversimplify the complexity of households' decision-making. The former assumes that the household represents others' opinions and overlooks gender and age differences that can create divergent preferences and power asymmetries (de Sherbinin et al., 2008; van Koppen and Hussain, 2007; Hussain, 2007).

This study draws predominantly on the collective model where it is assumed that decision-making takes place between two separate individuals, commonly a husband and a wife, but also involves other household members. This model allows consideration of both co-operative and non-cooperative bargaining; which together offer several useful characterizations of intra-household decision-making. Independent action by spouses may or may not be Pareto efficient; where individuals have different preferences and bargaining power. Those with more bargaining power will have more control over assets and decision-making; which may change over time (Anderson et al., 2017; Doss and Meinzen-Dick, 2015).

In a non-farm context in South Africa, Booysen et al. (2013) find a mix of decision-making models depending on household characteristics. Collective was more likely in large households; a unitary and non-co-operative model was more likely in female-headed households; a collective and joint model was more likely where household heads were older; and bargaining was more cooperative where household heads were more educated. This variation in decision-making models potentially also applies in rural settings. Other studies have explored the impacts of information on multiple household members, how they work collectively to meet their needs, and the role of social context (norms and rules) in multiple domains (household, community, state and market) (Lambrecht, 2017).

Household head categorization is also important for policy (Quisumbing et al., 2014). The most frequent categorization is whether households are male- or female-headed (Shaner et al., 1982). Disaggregating female-headed households into *de jure* and *de facto* provides increased understanding of how these households differ in relation to endowments and structural constraints (de la O Campos et al., 2016). *De-jure* female-headed households are often the poorest and most disadvantaged (Food and Agriculture Organization of the United Nations, 2011b).

Based on who has the greatest level of farm managerial control (in relation to investments, production subunits, labour allocation and profit), categorizations include male-managed; female-managed; separately managed; and jointly managed. All four systems exist in Africa. However, within SSA, male-managed systems dominate and jointly managed systems are less prevalent compared to Asia and Latin America (Meinzen-Dick et al., 2012). Female-headed households

comprise approximately 25% in SSA with the proportion varying across countries: for example, 26% in Mozambique, 43% in Zimbabwe and 25% in Tanzania (Food and Agriculture Organization of the United Nations, 2011a,b).

'Jointness' is frequently used in the literature as an indicator of gender equality. Ideally, if assets are owned jointly by men and women and decisions are made jointly, then there is likely to be less gender inequality. However, establishing the jointness of decision-making is complex: people tend to select 'joint' with further discussions revealing that one person makes most of the decisions (Meinzen-Dick et al., 2012); and jointness can represent conflict as well as cooperation (Njuki et al., 2014). Input into decision-making may be a more valuable indicator of empowerment, with women valuing substantial input and consensus more highly (Doss et al., 2014). In households where women are more educated and less involved in field work, there is a higher degree of consensus about which spouse has decision-making authority (Anderson et al., 2017).

2.3. Influences on household decision-making

The literature identifies a range of socioeconomic influences on decision-making, including: age; marital status; children; education; farming experience; time spent on farm; economic contribution; attitude; ownership of assets; income; farm size; family structure; networks (Doss et al., 2014; Doss and Meinzen-Dick, 2015; Mutenje et al., 2016); remittances; agricultural terms of trade (Matshe and Young, 2004); extension availability/quality (Wheeler et al., 2017); and health and practical mobility (Anderson et al., 2017; Djurfeldt et al., 2018). This list reflects a range of livelihood capitals (Ellis, 2000) and underscores the highly heterogeneous nature of farming households and the complexity of influences on decision-making.

Control of household assets, particularly land, has a significant influence on decision-making. It is critical for a woman's bargaining power and for improved outcomes in agricultural households (Doss and Meinzen-Dick, 2015; Quisumbing, 2010). In Africa, although men own the majority of individually owned assets there is also a significant amount of joint land ownership (Johnson et al., 2016). The latter positively influences female participation in farm decision-making, and the relationship is stronger where there is sole female ownership (Doss et al., 2014). However, there is stronger evidence of increased female participation in decision-making rather than female influence on decision-making outcomes (Meinzen-Dick et al., 2011).

More specifically, it has been found that women in Malawi with a higher decision-making power index—based on level of involvement in key farm decisions, marketing and household expenditure—had a greater influence on farming practice selection (Mutenje et al., 2013). Female participation in decision-making was positively influenced by education (both female and male), marital status and skills training, but negatively influenced by religion and informal networks.

The gender balance of decision-making is influenced by changing patterns of farm management through urbanization, increased out-migration and mixing of groups with different norms (Njuki et al., 2014). As a result, gender divisions in labour and decision-making have been described as 'eroding' and 'less rigid' (Meinzen-Dick et al., 2012; Peters, 1986). In particular, the social norms that influence land access and decision-making are 'dynamic and evolving' as markets and the value of inputs change (Lambrecht, 2017).

2.4. Division of labour and its influence on household decision-making

Traditionally, many work patterns have been entrenched along gender lines in African agriculture: for example, men care for cattle and work the land while women undertake other arable tasks, care for small livestock and dairy cattle, and perform household activities (Peters, 1986). The inclusion of dairy cattle reflects that women look after livestock housed and fed around the home (Food and Agriculture Organization of the United Nations, 2011b). In SSA, women have responsibility for food crops; while men have primary responsibility for cash crops with women providing the labour (Mehra and Esim, 1997). A Tanzanian study found that men prefer to irrigate high-value crops that can be harvested in bulk and sold in larger volumes. Whereas, women prefer crops that can be harvested in smaller quantities over a longer period for home consumption or selling locally for regular income (Njuki et al., 2014). Another Tanzanian study found that women had higher input into minor household expenditure, food production and cash crops, and the lowest input into major household expenditure (Doss et al., 2014).

Overall, we concur with McGregor et al. (2001) that drawing from more than one methodology provides a better understanding of the integrated nature of household decision-making. This paper therefore models decision-making of multiple household members across all household income domains to acknowledge the diversity of household headship, and incorporates qualitative data to provide further insight.

3. Methodology

3.1. Location details

This study used mixed methods and collected quantitative (extensive household surveys) and qualitative (follow on interviews in focus groups) data from households in six irrigation schemes (two each in Mozambique, Zimbabwe and Tanzania). These households are part of a project, funded by the Australian Centre for International Agricultural Research, to increase irrigation water productivity and profitability. The selection of countries followed a scoping study of nine African countries and considered local expertise, favourable policies and institutions, and the potential to increase food production. Schemes were selected based on institutional capacity, ability to improve agricultural practices, accessibility, and collaboration with local agencies. The schemes differ in number of irrigators, irrigated plot size, gender, age of household heads (HH), and dependence on off-farm work (Table 1).

In Tanzania, males dominate as HHs; whereas, females dominate in Zimbabwe and there are more non-married/de facto households in Mozambique. For more details about the schemes and irrigation within the countries see: Mdemu et al. (2017) for Tanzania; Moyo et al. (2017) for Zimbabwe; and de Sousa et al. (2017) for Mozambique.

3.2. Household quantitative survey

Households on the six schemes were surveyed in 2014 using a questionnaire. This was based on: various findings from the literature; in-depth local knowledge about irrigation and agriculture in the three countries; and informed by discussions with irrigators, extension officers, and local leaders. The survey was checked by all research and government organizations involved (including experienced local leaders, extension officers and irrigators) before it was piloted with around ten households. The survey was designed to collect a broad range of quantitative data on household demographics and production, and included specific questions on household decision-making. Enumerators were trained to ensure the questionnaire was administered consistently through face-to-face interviews with households. In the three smallest schemes we attempted to survey all households. Whereas, in each of the three larger schemes, 100 households were purposefully recruited and stratified on plot location (upstream, middle or downstream) and resource endowment. The interviews were of approximately two hours duration and undertaken with HHs and/or other main decision-makers. Female participation was encouraged. While a man was frequently the HH, he was often not available. Consequently, the gender balance among the respondents was relatively even (59% men). From the perspective of analyzing decision-making in farm households with increasingly complex livelihood strategies, this sample was considered ideal as it included a relatively even number of men and women

Table 1
Demographic information for irrigation schemes.

Demographics of scheme	Irrigation schemes					
	Tanzania		Zimbabwe		Mozambique	
	Kiwere	Magozi	Mkoba	Silalatshani	25 de Setembro	Khanimambo
Number of households overall in schemes	168	578	75	845	38	27
Mean number of household members	6	5.5	5.3	6.7	6.8	6.4
Mean age of HH	46	42	62	56	57	59
Gender in household (% households):						
Males	51	54	52	47	53	49
Females	49	46	48	53	47	51
HH gender (% households):						
Male	90	87	37	69	68	33
Female	10	13	63	31	32	67
Marital status of HH (% households):						
Married/de facto	84	78	46	78	68	44
Other: never married/married but not living with partners/divorced/separated/ widowed	16	22	54	22	32	56
Irrigated area (ha)	195	939	10	442	38	10
Mean irrigated area per household (ha)	0.97	1.17	0.11	0.41	1.10	0.67
Individuals working on-farm (% households)[a]	69	100	87	83	56	32
Individuals working off-farm (% households)	31	25	52	46	47	33
Mean number of cattle	1.4	4.2	3.7	5.6	0	1.2
Mean number of children < 6rs in household	0.6	0.9	0.6	1.1	1.0	0.9
Average size of male-owned plots (ha)	1.78	1.37	0.62	0.98	0.71	1.06
Average size of female-owned or female-male jointly owned plots (ha)	0.16	0.19	0.70	0.74	1.06	1.47

[a] An individual can work both on- and off-farm; or work neither on- nor off-farm.

whether they were the HH or not.

The stratification and sampling resulted in a survey of 402 households across the three countries, covering 478 irrigated plots (255 solely controlled by males; 173 by females) and 301 rain-fed plots (158 solely controlled by males; 119 by females).

The survey's decision-making questions were with respect to four production types: irrigated crops, rain-fed crops, cattle and smaller stock (e.g. sheep, goats, chicken and ducks). For each, farmers had to answer six decision-making questions (24 in total) on: i) what crops to grow or animals to raise; ii) implement use; iii) purchase and use of inputs; iv) work times; v) when and where to sell produce; and vi) use of farming proceeds. The respondent could choose who made the decision from a provided list: household head, husband, wife, son, daughter, parent, grandchild, husband and wife, or other (such as other joint combinations).

3.3. Focus group qualitative research

Following on from the large-scale quantitative surveys and the findings from their analysis, we conducted focus groups within the schemes to gain additional insights on irrigated farm decision-making and gender dynamics. Two focus groups were conducted within each scheme in July-September 2016. The aim was to obtain insights on levels of input into decision-making on the schemes, whether decision-making involves cooperative or non-cooperative behaviour between spouses, who makes the final decision, and the importance of household members' engagement in income-diversification. One focus group was with females-only, predominantly from female-headed households, and one was with women and men from male-headed households (mixed group). This provided the maximum opportunity to explore the balance in household decision-making and other factors that influence the decision-making dynamics. The discussions focused on five themes: community-level; household-level; technology access; water governance; and irrigation impacts. Researchers noted key points on flip charts and took verbatim notes of individual statements. The focus groups used SiNdebele in Zimbabwe; Swahili in Tanzania and Changana in Mozambique.

3.4. Farm decision variable and regression analysis

The gender balance of decision-making was determined by coding the responses to the 24 decision questions: (1 = female, 0 = joint and 1 = male). Each of these variables was then rescaled to create a gender balance decision-making index for each of the four production types, either: 1) all female (all six decisions made by a female); 2) mainly female (2 or 3 decisions made by a female); 3) balanced; 4) mainly male; or 5) all male. Hence, an increase in this index indicates more male decision-making. Besides reflecting the level of male (or female) involvement in decision making, this index also allows for a more nuanced understanding of decision-making dynamics—reflecting whether decision-making was unitary (either 1 or 5) or collaborative (2–4). Taking the average of the four production types, we created an overall index of the gender balance of decision-making. It was not always possible to identify the gender if the decision-maker was a 'parent', 'grandchildren' or 'others'. These answers accounted for around 5% of total responses, with the majority of them being 'parent'. To avoid excluding these observations, we classified them as 'balanced'.[2]

Ordered probit regression[3] modelled the influences on the gender balance of decision-making (Equation (1)), namely:

$$y^* = x\cdot\beta + \varepsilon \quad (1)$$

The dependent variable y is a latent variable measuring the exact but unobserved extent of the gender balance of decision-making; x is a vector of independent variables representing the socio economic and property characteristics of the households; β a vector of parameters; and ε an error term. Appendix A provides descriptive statistics.

We observe $y = 1$ (all female), if $-\infty \le y^* \le \mu_1$; $y = 2$ (mainly female) if $\mu_1 \le y^* \le \mu_2$; $y = 3$ (balanced) if $\mu_2 \le y^* \le \mu_3$; $y = 4$ (mainly

[2] An index for each production type was also created. The indexes of these six aspects are highly correlated and highly correlated with the overall index (correlation coefficient > 0.84). We therefore report the overall index.

[3] Results were obtained using both ordered logit and ordered probit models. The test results between the two models were very similar; albeit ordered probit had slightly higher explanatory power, hence, the ordered probit results are reported here.

male) if $\mu_3 \leq y^* \leq \mu_4$; and $y = 5$ (all male) if $\mu_4 \leq y^* < +\infty$, where y is a rough categorization of y^*, μ_1, μ_2,μ_3 and $u4$ are parameters to be estimated.

Ordinary Least Squares (OLS) regression (Equations (2)) modelled how the decision-making dynamic as well as other factors influence the six types of household income.

$$I = w\delta + \nu \quad (2)$$

Equation (2) was estimated for each income type (I); w is a vector of independent variables; δ is a vector of parameters to be estimated and ν is an error term. Pre-testing suggested that income should take a logarithmic form for a better fit. We tested whether the decision-making index was endogenous with household income, using the gender of HH as a valid instrument. For example, it is possible to argue that differences in household income help drive the gender balance (based on the literature where higher assets/income owned by females are associated with greater female decision-making). However, results suggested that the decision-making index was not endogenous with any type of household income.[4] Again, independent variables are based on the literature. We also accounted for other potential influences by including a dummy for HH being single or widowed, and number of males in the household.

4. Results and discussion

4.1. Overview

Table 2 provides an overview of the gender balance of household decision-making by country.[5] The husband and/or the wife predominantly make farm decisions, with other household members making a smaller proportion (ranging from 8% for cattle to 12% for irrigation). Looking at the overall decision-making across all three countries, there is a surprisingly even proportion across the decision categories with only a small skewness toward male-dominated decision-making (from 16–23%). However, large differences exist amongst the three countries (Table 2) and the schemes (Appendix B).

In Tanzania, men make most decisions and this probably reflects social norms. Females make most decisions in Zimbabwe, which probably reflects that many men work away. However, both countries report 20% balanced decision-making. Balanced decision-making was rare in Mozambique, with decisions made mostly by men in one scheme and mostly by females in the scheme where a large proportion of men work away in South Africa. In Zimbabwe, female-only decision-making is likely if the female HH is widowed. Households where females make all the decisions accounted for 56% of widowed HHs, compared to 18% amongst other households.

In Mozambique and Zimbabwe, production type clearly influences the gender balance of decision-making; whereas, all decisions are male-dominated in Tanzania. Across all schemes, decision-making about cattle is male-dominated while small stock is female-dominated (except for Mozambique). These findings are consistent with the literature (Peters, 1986). Apart from small stock, female decision-making is highest for irrigation: particularly in Zimbabwe and Mozambique where the proportion of all-female decision-making is higher than for any other production and higher than male-only. This is a new finding not previously reported in the literature.

We analyzed how respondents' gender was associated with the ranking of decision-making (Table 3) to assess whether males report decision-making differently to females. The majority of female respondents (74%) report either female-only or more female decision-making; whereas male respondents report male dominated or joint. As many female respondents are *de jure* HH, we excluded widowed HH and found that now 62% reported female-only or more female decision-making. Excluding widowed HH, equal decision-making is almost even but women still rate female decision-making higher. This probably reflects the prevalence of *de-facto* female HHs in this category, who have an increased role in decision-making. This is contrary to the findings of Ellis and Allison (2004) but consistent with Bryceson (2002) and Lastarria-Cornhiel (2006). Reflecting this, male HH respondents were more likely to be spending more time on-farm; hence, were more involved in decision-making. We further tested the impact of collaborative decision-making by combining more female, equal and more male into one category called collaborative (not reported in Table 3).

This analysis suggests that there were no significant differences between male and female respondents in their rating of collaborative decision-making. This adds nuance to Booysen et al.'s (2013) urban findings. In this rural setting, the balance in collaborative decision-making between a husband and wife depends on the HH's gender, which in turn depends on the presence of the male in the household.

Table 2
Decision-making index by production type and country.

	Country	n.	All female %	More female %	Balanced%	More male %	All male %
Overall	Tanzania	190	4.2	7.4	21.6	29.5	37.4
	Mozambique	33	18.2	39.4	6.1	24.2	12.1
	Zimbabwe	168	29.8	29.2	20.2	11.9	8.9
	All	391	16.4	19.4	19.7	21.5	23.0
Rain-fed	Tanzania	129	4.7	7.0	19.4	27.1	41.9
	Mozambique	24	16.7	50.0	0.0	29.2	4.2
	Zimbabwe	160	51.9	3.8	19.4	1.3	23.8
	All	313	29.7	8.6	17.9	14.1	29.7
Irrigated crops	Tanzania	181	5.5	5.0	21.0	25.4	43.1
	Mozambique	31	32.3	25.8	6.5	9.7	25.8
	Zimbabwe	167	58.1	1.8	19.2	1.2	19.8
	All	379	30.9	5.3	19.0	13.5	31.4
Cattle	Tanzania	39	2.6	0.0	33.3	5.1	59.0
	Mozambique	9	0.0	66.7	0.0	11.1	22.2
	Zimbabwe	119	26.9	7.6	21.0	10.1	34.5
	All	167	19.8	9.0	22.8	8.9	39.5
Small stock	Tanzania	94	7.2	8.5	22.3	8.5	53.2
	Mozambique	4	25.0	0.0	25.0	0.0	50.0
	Zimbabwe	156	51.3	16.7	18.0	3.2	10.9
	All	254	34.7	13.4	19.7	5.1	27.2

4.2. Modelling the influences on the dynamics of decision-making: overall and production types

Table 4 presents the results of the ordered probit decision-making regression and Table 5 the OLS income regression.

The regressions have no serious multicollinearity and the use of robust standard errors mitigated the issue of heteroscedasticity. The McKelvey & Zavoina R^2 for the ordered probit models and R^2 for the OLS models are all satisfactory, indicating overall model fitness.

The ordered probit regression identified a wide range of influences on the gender balance of decision-making. One of the strongest findings is the significant difference between the countries (the comparison is Tanzania). This is both with respect to variations in the overall decision-making index and the individual production indexes. Across all decision types (except cattle), females play a significantly greater role in Zimbabwe than in Tanzania. In Mozambique, females play a significantly greater role in overall and rain-fed decision-making, while they have a significantly lesser role in small livestock decision-making.

[4] The endogeneity test was implemented after a two stage least squares regression, under the null hypothesis that the specified endogenous regressor (gender decision-making index) is exogenous. For each of the household income models, the null hypothesis could not be rejected at the 0.05 significance level.

[5] Results for Zimbabwe and Tanzania are included in Appendix B. Figures for Mozambique are not disaggregated due to low numbers.

Table 3
Decision-making by female and male respondents (by all respondents and with widowed respondents excluded) (%).

Decision-making	All respondents		Widowed respondents excluded	
	Female	Male	Female	Male
All female	38	1	28	10
More female	36	7	34	15
Equal	14	24	22	24
More male	6	32	8	25
All male	6	36	9	27
	Pearson chi2(4) = 196.11 Pr = 0.00		Pearson chi2(4) = 125.68 Pr = 0.00	

Table 4
Ordered probit modelling of influences on farm decisions (a higher decision index (DI) indicates greater male decision-making).

Independent variables	*Overall DI*	*Rain-fed DI*	*Irrigated DI*	*Cattle DI*	*Small stock DI*
HH male	1.512***	1.766***	1.165***	1.252***	1.373***
% of males in household	0.554	0.256	0.321	0.714	1.007**
HH age	−0.002	0.005	0.002	0.011	−0.003
HH single (dummy) [1]	0.208	0.36	0.117	−0.0004	0.356
HH widowed (dummy) [1]	0.001	-0.208	−0.356	−1.122***	0.489
Household size	−0.008	0.001	−0.03	0.018	−0.068
% of on-farm work by HH	0.003	0.007**	0.003	0.010***	0.004
HH education: primary school[2]	−0.001	−0.182	0.073	−0.277	−0.168
HH education: above primary school[2]	−0.022	−0.127	−0.013	0.259	0.003
Household members working away	0.043	−0.101*	0.059	0.008	0.145**
At least one household member's health condition is poor (dummy)	−0.021	−0.161	0.133	−0.246	0.143
Country: Mozambique[3]	−0.599*	−0.558*	0.28	−0.014	4.566***
Country: Zimbabwe[3]	−0.586**	−0.944***	−0.672**	−0.148	−0.836**
Household members < 6 years and Tanzania interaction	−0.051	−0.167	0.074	0.197	−0.18
Household members < 6 years and Mozambique interaction	0.404	0.075	−0.126	−0.255	−4.946***
Household members < 6 years and Zimbabwe interaction	−0.372*	−0.304	−0.128	−0.512*	−0.104
Total land area not owned by only male	−0.208***	N.A.	N.A.	N.A.	N.A.
Cattle not owned by only male	−0.011	N.A.	N.A.	−0.051	N.A.
Other livestock not owned by only male	0.002	N.A.	N.A.	−0.022	N.A.
Poultry not owned by only male	0.013**	N.A.	N.A.	0.01	0.003
Total rain-fed area not owned by only male	N.A.	−0.290**	N.A.	N.A.	N.A.
Total irrigated area not owned by only male	N.A.	N.A.	−1.083***	N.A.	N.A.
μ_1	−0.398	0.284	0.107	0.598	0.46
μ_2	0.745	0.769	0.406	1.334	1.044
μ_3	1.518***	1.480**	1.134**	2.219***	1.683**
μ_4	2.339***	2.018***	1.589***	2.577***	1.918***
Observations	357	286	345	148	229
Wald chi[2]	229***	159***	226***	148***	594***
McKelvey & Zavoina R^2	0.55	0.57	0.52	0.60	0.56

Notes: [1]Reference group is HH married at present. [2]Compared to the reference group of HH, is below primary school. [3]Country reference group is Tanzania. [3]*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.
N.A.—not applicable; dependent variable is the decision-making index 1 = fully female to 5 = fully male.

Where the HH was male, decisions were significantly more likely to be male-dominated, which is consistent with the finding that in male-managed farming systems men are completely or mostly controlling production and decision-making (Doss and Meinzen-Dick, 2015; van Koppen and Hussain, 2007; Hussain, 2007). Other factors are also significant: i) the larger the percentage of farm work carried out by the HH, the more males dominate rain-fed and cattle decisions; ii) if the HH is widowed (most likely a female), cattle decisions are less likely to be male-dominated; and iii) the larger the percentage of males, the more men dominate small stock decision-making. The last finding was unexpected and suggests that the more male-dominated the household, the more men infringe on the traditionally female-dominated area of small stock (Peters, 1986). This study confirms the link often made in the literature between decision-making and control over farmland (Doss et al., 2014). There is a significant and negative relationship between the total size of land not owned by males-only and the overall decision-making index. There is a similar relationship between the rain-fed and irrigated areas not owned by males-only, and the index for rain-fed and irrigated production. That is, females have a larger role in decision-making if they formally have full or part control over the land. The focus group discussions across all schemes repeatedly highlighted that men predominantly control land and that it was difficult to talk about the control of land. This supports the finding of Meinzen-Dick et al. (2011).

4.3. Modelling the influence of the dynamics of the decision-making environment on income

The dynamics of decision-making influenced income in several ways (Table 5). Total income was higher if decisions were made more by females, more by males, or by males-only. The estimated magnitude was 98%, 86% and 142%, respectively.

Table 5
OLS modelling of irrigation households' various forms of income.

Independent variables	*Total income*	*Farm income*	*Off-farm income*	*Rain-fed income*	*Irrigation income*	*Livestock income*
Overall decision-index (DI) (more female)[1]	0.683**	0.356	0.908*	N.A.	N.A.	N.A.
Overall decision-index (balanced) [1]	0.336	0.423	0.37	N.A.	N.A.	N.A.
Overall decision-index (more male) [1]	0.634*	0.261	1.113**	N.A.	N.A.	N.A.
Overall decision-index (all male) [1]	0.885***	1.095**	0.66	N.A.	N.A.	N.A.
DI (more female) rain-fed/irrigation/livestock[1]	N.A.	N.A.	N.A.	−0.749	−0.439	0.104
DI (balanced) rain-fed/irrigation/livestock[1]	N.A.	N.A.	N.A.	0.528	0.311	0.344
DI (more male) rain-fed/irrigation/livestock [1]	N.A.	N.A.	N.A.	0.28	0.012	-0.56
DI (all male) rain-fed/irrigation/livestock[1]	N.A.	N.A.	N.A.	0.683	0.228	−0.152
% of males in household	−0.927*	−1.096	−0.954	−0.212	−1.06	0.265
HH age	−0.015*	−0.001	−0.018	−0.008	−0.022*	0.025*
HH single (dummy) [2]	0.069	−0.102	−0.088	−0.557	0.224	0.72
HH widowed (dummy) [2]	0.01	0.017	0.419	0.137	−0.092	0.007
Household size	0.102	−0.119	0.183**	−0.062	−0.013	−0.025
On-farm work by HH (%)	−0.007**	−0.006	−0.013**	0.002	−0.006	−0.006
Household education: primary school[3]	−0.112	−0.421	−0.085	−0.367	−0.695**	0.596
Household education: above primary[3]	−0.171	−0.682	0.224	−0.62	−0.876*	0.688
Number of household members working away	−0.07	−0.02	0.018	−0.156	0.055	0.091
At least one member's health condition is poor	−0.183	0.506	−0.302	0.766*	0.546	−0.3
Number of household members < 18 years	−0.101	0.097	−0.084	0.103	0.029	0.012
Country: Mozambique[4]	0.035	−0.198	1.208	−1.885*	0.557	−0.129
Country: Zimbabwe[4]	0.404	−2.046***	1.896***	−3.608***	−2.025***	−1.935**
Rain-fed area	0.132	0.482***	N.A.	0.736***	N.A.	N.A.
Irrigated area	0.372***	0.537***	N.A.	N.A.	0.697***	N.A.
Uncultivated land area	−0.390***	-0.204	N.A.	N.A.	N.A.	N.A.
Cattle	0.014***	0.017*	N.A.	N.A.	N.A.	0.049***
Other livestock	0.008*	0.009	N.A.	N.A.	N.A.	0.029***
Poultry	0.008	0.014**	N.A.	N.A.	N.A.	0.006
Land-maize (%)	−0.005	−0.013	N.A.	0.005	−0.007	N.A.
Land-sorghum (%)	−0.008	0.001	N.A.	0.027*	−0.003	N.A.
Land-groundnut (%)	−0.011	−0.02	N.A.	0.012	−0.012	N.A.
Land-tomato (%)	−0.001	−0.004	N.A.	−0.02	0.008	N.A.
Land-rice (%)	0.002	−0.001	N.A.	−0.015	0.006	N.A.
Land-onion (%)	0.132***	0.087	N.A.	0.134**	0.117*	N.A.
Generator	0.15	0.884*	−0.689	0.136	1.060*	0.6
Car/motorbike	0.278	−0.182	1.137***	−0.389	−0.121	0.531
Phone	0.338	0.174	0.646	0.027	0.376	0.236
Borehole/water pump	0.757***	0.186	0.719*	0.098	0.473	-0.275
Farm tools	0.002	0.433	−0.321	0.08	0.266	0.802
Constant	6.953***	7.101***	3.765***	3.958**	6.812***	0.379
Observations	357	357	357	286	345	251
F-stat	6.96***	7.92***	4.05***	7.14***	10.39***	5.70***
R^2	0.266	0.374	0.175	0.313	0.386	0.252

Notes: [1]Reference group is all female decision-making. [2]Reference group is HH married at present. [3] HH education reference group is below primary school. [4] Country reference group is Tanzania. *** p < 0.01, ** p < 0.05, * p < 0.1 N.A.—not applicable.

The literature suggests that *de facto* female-headed households are the poorest households as they do not benefit from off-farm incomes and have fewer assets and human resources (de Sousa et al., 2017; Safilios-Rothschild, 1985). However, our models did not find significant differences between widowed and married HHs, or between single and married HHs. If decisions were made by males-only, on-farm income was higher than if decisions were made by females-only (estimated 199%). This is probably due to the additional availability of labour. However, this might also reflect that some absent male HHs make decisions by mobile phone and regularly participate in farm work during weekends and critical farm periods. Male off-farm work provides significant income, allowing for the purchase of inputs and hiring of non-family labour, as was found in Mozambique (de Sousa et al., 2017).

This potentially allows better links to markets through the household having a presence in town. If decisions are made more by females or more by males, off-farm income is estimated at 148% or 204% higher than if decisions are made by females-only. These two categories of decision-making reflect that male heads of households work off-farm but are still involved in farm decision-making. There are no significant relationships between the decision-making index for the individual production types and the income from these productions.

As is recognized in the literature (Ellis and Allison, 2004; Manero, 2016), off-farm work is very important for household well-being; both for supporting farm production by financing farm inputs, but also to pay for health and education. Reflecting this, we found that the larger the proportion of farm work carried out by the HH (i.e. the HH is working less off-farm) the lower the total and off-farm income. Additionally, we found that irrigation accounts for 65% of farm income and 42% of household income across the six schemes. Our findings show clear evidence of the complexity of households' livelihood strategies and the importance of the dynamics of decision-making on total, on-farm and off-farm income. This suggests that when households allocate their labour resources they make trade-offs between the dryland, irrigation and livestock components of their farm and their off-farm activities. That is, they focus on maximizing their overall return rather than the return from individual livelihood strategies.

Total income is lower when there is a larger proportion of males in the household, which at first sounds counterintuitive. This probably reflects that in a household with a high proportion of males there are more children attending school: traditionally, rural households prioritize the education of male children. This leaves less time for on-or off-farm work by male children. Male children are also less productive around the house as they neither fetch water nor look after younger siblings, but still require care; thereby reducing women's time for farm work.

There are also significant country differences in income. For all production types and compared to Tanzania: in Zimbabwe, farm income was lower while off-farm income was higher, and rain-fed income was significantly lower in Mozambique. The influence of ownership of productive resources was as expected: i) the larger the rain-fed area the higher the total farm and rain-fed income; ii) the larger the irrigated area the higher the total, farm and irrigation incomes; iii) the more cattle the higher total, farm and livestock income; iv) the more 'other livestock' the higher the total and other livestock incomes; v) the more poultry the higher the farm income; vi) having a borehole/water pump was associated with higher total income; vii) having a generator was associated with higher farm and irrigated crop incomes; and viii) having a car/motorbike or borehole/water pump was associated with higher off-farm income.

Points six, seven and eight suggest resource ownership increases income, which allows the household to acquire more assets and increases the ability to earn money. The use of motorbikes as taxis is widespread, especially in Tanzania. A household's borehole or water pump significantly reduces the time spent fetching water. This increases time available for fieldwork; facilitates more irrigated crop production at the house plot; and enables more time for off-farm activities.

4.4. Focus group findings

In Zimbabwe, both female-only and mixed focus groups report that decision-making about the use of water and money was joint. However, in both schemes the female-only focus group reported that sometimes men overruled women and spent money for their own pleasure (beer or cigarettes). Also, that most household arguments were over how to spend scarce resources. Some women said that women made most decisions in the households where the men were absent, and as long as the work was completed there was no interference from men.

Despite the quantitative findings of predominantly male decision-making, it was the Tanzanian women who spoke most and appeared more confident during visits and in focus groups. This might suggest that women in male-dominated households are active in decision-making and are more interested in having substantial input and consensus rather than reporting whether a decision is joint (Doss et al., 2014). We cannot answer definitely, but it is interesting to posit whether women are under-reporting their decision-making involvement (Lastarria-Cornhiel, 2006) potentially to support consensus and/or because they are confident of their influence.

The discussions suggested that joint decision-making was most common for irrigation management and farm work. However, men were mainly responsible for finding markets as found by Njuki et al. (2014). Men primarily made the decisions about spending money, with a Tanzanian farmer stating that 'men dominate in control of income earned from irrigated crops so as to save money for investing in the next season' (male farmer, aged 50, Magozi). Male farmers argued that 'women have unnecessary expenditures such as buying new clothes and luxury things which is why they have to control income' (male farmer, aged 24, Magozi). Whereas, women argued that they have necessary expenses (e.g., clothes, cooking tools) and often secretly sell crops to obtain money. These opinions lend support to the notion that African households are less likely to pool income (Lastarria-Cornhiel, 2006). Despite this evidence of non-cooperation (in both Tanzania and Zimbabwe), women reported that the level of domestic conflict had reduced during the project as income increased and this has improved marriage and power relations between men and women (female farmer, aged 40, Kiwere; male farmer, aged 48, Magozi).

In Mozambique, discussions suggested that most farmers are now women, as men increasingly work in towns or in South Africa. While some absent men make decisions in *de-facto* female-headed household, women make most of the day-to-day decisions. Most women stressed that they are acting on male advice even though they do most of the fieldwork, make the day-to-day decisions, and take a separate share of the profit:

> We share the decision about what to produce and how. But most of the time he is the one leading… when it is time to harvest he is always present and making the deals, but I am the one keeping the money and at the end I get a small share and the rest is managed by him (female farmer, aged 35, Silalatshani).

Another female mentioned:

> The women are the ones spending more time in the field, but all the decisions have already been made at home. The men have more decision-making power in the household. Since I am the one in the plot I remain in control of the production, but I cannot say the same about the land; … it is complicated to talk about the control of the land (female farmer, aged 79, 25 de Setembro).

While men dominate decision-making, women participate most in fieldwork, meetings and gathering of farming information. Focus group discussions also repeatedly touched on the division of work within the household, and many women mentioned that women have a larger role in decision-making if the HH works off-farm.

Focus groups and field observations in all three countries, confirm our quantitative findings that women do most of the farm work, especially when it comes to irrigation. In Zimbabwe, many mentioned that women and men grow much the same crops under irrigation. However, when the project introduced the notion of high-value crops, it was women that were most active in adopting them: to increase their income to invest in farming, improve food security, nutrition and their children's education. This is inconsistent with the literature that indicates women's existing labour roles may limit their ability to take advantage of new opportunities (Doss et al., 2014). The uptake of high-value irrigated crops represents a change of mind-set from subsistence to commercial farming, with part of the surplus used for education and food security (Bjornlund et al., 2018). In addition, growing higher value cash crops should increase women's bargaining power and their influence on decision-making (Doss and Meinzen-Dick, 2015).

The discussion around livestock reflects the quantitative findings and the literature (Peters, 1985). Men mainly look after cattle and donkeys while women take care of goats and chickens. For example:

> Men's first priority is large livestock like cattle, then consumption … us women value crop production more than men…. somehow, large livestock comes last to our priorities, but we also have a saying that a homestead without chickens shows the absence of a woman (female farmer, aged over 65, Mkoba).

Women also reported that the introduction of soil moisture monitoring tools had allowed them to significantly reduce their time spent irrigating (often by more than 50%). This time has reportedly been used to: tend the home garden and small livestock to improve food security and household income; increase their yield through more weeding; or increase their off-farm income activities (e.g. baking buns for sale). Income diversification empowers women and strengthens their bargaining position. This supports the importance of diversified incomes as identified by Manero (2016) in Tanzania.

5. Conclusion

This study explores how household decision-making dynamics influence household income in six small-scale irrigation schemes in southern Africa. While many of the traditional norms still prevail, fundamental changes are emerging as the dynamic of decision-making changes, due to increased livelihood diversification and the introduction of high-value crops.

Household income is influenced by how a household allocates their labour resources (between on-farm and off-farm work) and the gender balance of decision-making. Female-only decision-making households had the lowest total and farm income. This probably reflects that *de jure* female-headed households without the support of a husband have no off-farm income and fewer labour resources. Households where men made all the decisions had the highest total and farm income. However, households with a higher female than male contribution to decision-making ran a close second, which probably reflects that these are *de facto* female-headed households receiving extra income from off-farm and with access to extra farm labour during critical farming periods.

In conclusion, our findings clearly support that households' decision-making dynamics strongly influence total household income. Rather than maximizing the income from any individual component of their livelihood strategy, households make trade-offs between irrigation, dryland and off-farm work and allocate their labour resources to maximize household income. Hence, resource allocation decisions are not always made to ensure the maximum benefits from investments in irrigation infrastructure; and consequently, irrigation will not realise its potential and anticipated contribution to improving rural livelihoods and food security. In many African countries, a fundamental paradigm shift in agricultural land and water policies is needed. As well as considering net social benefits at the basin-scale, policies need to have a strong focus on making irrigation profitable so that it becomes a primary source of income. Farming households will then have confidence to reallocate resources to this activity. For irrigation schemes to become profitable, there needs to be a transition from growing staples to commercial crops so that household income can meet food, health and educational needs. Policies need to facilitate: basin-level hydrological and environmental considerations; a consolidation of farming plots into viable units; security of land tenure; improved market and transport linkages (so crops meet market demand and attract higher prices); and access to better agronomic and irrigation information (including a focus on female-provided education). Nevertheless, transitioning small-scale irrigation schemes into financially viable units is, and will continue to be, a challenging and complex process.

Acknowledgments

This study was part of the project "Increasing irrigation water productivity in Mozambique, Tanzania and Zimbabwe through on-farm monitoring, adaptive management and Agricultural Innovation Platforms" partially funded by the Australian Government via the Australian Centre for International Agricultural Research (< GN1 > LWR/2016/137 < /GN1 >). CGIAR's Research Program on Water, Land and Ecosystems (WLE), CGIAR Fund Donors and Australian Research Council (FT140100773) also provided funding. The following project researchers contributed to data collection: Nuru Mziray, Wilson de Sousa, Etevaldo Cheveia, Emmanuel Kimaro and Andre van Rooyen. Comments from two anonymous reviewers much improved this manuscript.

Appendix A. Definition and summary statistics of variables

Variable name	Definition	Mean	Std. Dev.
Overall decision-index	1 = all female, 2 = more female, 3 = balanced, 4 = more male, 5 = all male	3.16	1.41
Rain-fed decision-index	As above	3.09	1.64
Irrigation decision-index	As above	3.11	1.66
Cattle decision-index	As above	3.49	1.57
Small stock decision-index	As above	2.78	1.64
Total gross income	Household's total income (US$), natural logarithm	6.59	1.71
On-farm gross income	Household's on farm income (US$), natural logarithm	5.33	2.66
Off-farm gross income	Household's off farm income (US$), natural logarithm	4.37	2.76
Rain-fed gross income	Household's income (US$) from rain-fed crops, natural logarithm	2.28	2.80
Irrigation gross income	Household's income (US$) from irrigated crops, natural logarithm	4.42	2.93
Livestock gross income	Household's income (US$) from livestock, natural logarithm	2.01	2.64
Overall decision-index (DI) (more female)[1]	1 = overall decision index is 'more female'; 0 = otherwise	0.20	0.40
Overall decision index (balanced) [1]	1 = overall decision index is 'balanced'; 0 = otherwise	0.18	0.39
Overall decision index (more male) [1]	1 = overall decision index is 'more male' 0 = otherwise	0.22	0.41
Overall decision index (all male) [1]	1 = overall decision index is 'all male'; 0 = otherwise	0.24	0.42
DI (more female) for rainfed/	1 = DI for rain-fed/irrigation/livestock production is 'more female'; 0 = otherwise	0.09	0.29
irrigation/		0.06	0.23
livestock[1]		0.12	0.33
DI (balanced) for rain-fed/	1 = DI for rain-fed/irrigation/livestock production is 'balanced'; 0 = otherwise	0.15	0.36
irrigation/		0.17	0.38
livestock[1]		0.30	0.46
DI (more male) for rain-fed/	1 = DI for rain-fed/irrigation/livestock production is 'more male'; 0 = otherwise	0.14	0.35
irrigation/		0.13	0.34
livestock [1]		0.06	0.24
DI (all male) for rainfed/ irrigation/	1 = DI for rain-fed/irrigation/livestock production is 'all male'; 0 = otherwise	0.31	0.47
livestock[1]		0.33	0.47
		0.29	0.45
Male HH	1 = HH is male; 0 = otherwise	0.71	0.45

% of males in household	% of male household members in the household	0.52	0.20
Age of HH	HH age (years)	51.7	16.62
Marital status of HH, single[2]	1 = HH is currently single; 0 = otherwise	0.09	0.29
Marital status of HH, widowed[2]	1 = HH is widowed; 0 = otherwise	0.18	0.38
Household size	Number of household members	5.54	2.27
On-farm work of HH	HH's on-farm work time (%)	78.8	29.7
HH: primary school[3]	1 = HH's education level-primary school; 0 = otherwise	0.48	0.50
HH: more than primary school[3]	1 = HH's education level-more than primary school; 0 = otherwise	0.21	0.41
Household members away	Number of household members working away from home	1.90	2.10
Poor health	1 = at least one household member's health condition is poor; 0 = otherwise	0.16	0.37
Mozambique[4]	1 = Mozambique household; 0 = otherwise	0.08	0.27
Zimbabwe [4]	1 = Zimbabwe household; 0 = otherwise	0.42	0.49
Total land ownership	Total land area (hectares) not solely owned by men	0.51	0.98
Rain-fed ownership	Rain-fed area (hectares) not solely owned by men	0.30	0.66
Irrigated land ownership	Irrigated land area (hectares) not solely owned by men	0.17	0.33
Cattle ownership	Number of cattle not solely owned by men	0.49	1.86
Other livestock ownership	Number of other livestock that is not solely owned by men	0.98	3.13
Poultry ownership	Number of poultry that is not solely owned by men	5.29	12.9
Young children Tanzania	Tanzanian number of household member < 6 years	0.26	0.44
Young children Mozambique	Mozambique number of household member < 6 years	0.04	0.19
Young children Zimbabwe	Zimbabwe number of household member < 6 years	0.19	0.40
Rain-fed area	Total rain-fed area (hectares)	0.73	0.98
Irrigated land area	Irrigated land area (hectares)	0.75	0.78
Uncultivated land area	Uncultivated land area (hectares)	0.24	0.80
Number of cattle	Number cattle	3.57	10.1
Number of other livestock	Number other livestock	4.93	12.8
Number of poultry	Number poultry	10.4	16.1
Maize	Land area-maize (%)	61.8	39.4
Sorghum	Land area-sorghum (%)	3.01	11.5
Groundnut	Land area-groundnut (%)	2.17	7.52
Tomato	Land area-tomato (%)	6.32	18.7
Rice	Land area-rice (%)	21.5	37.9
Onion	Land area-onion (%)	0.13	1.35
Generator	1 = household owns generator; 0 = otherwise	0.07	0.26
Car/motorbike	1 = household owns a car or motorbike; 0 = otherwise	0.15	0.35
Phone	1 = household owns a mobile phone; 0 = otherwise	0.84	0.37
Borehole/water-pump	1 = household owns a borehole or water pump; 0 = otherwise	0.15	0.36
Farm tools	1 = household owns any animal driven tools, wheel-barrow, or ox/donkey cart; 0 = otherwise	0.44	0.50

Note: [1] Reference group is all female decision-making. [2] Reference group is HH married at present. [3]HH education reference group is below primary school. [4]Country reference group is Tanzania.

Appendix B. Decision-making index by production type and scheme

	Scheme	n.	All female %	More female %	Balanced%	More male %	All male %
Overall	Mkoba	68	41.2	30.9	13.2	4.4	10.3
	Silalatshani	100	22.0	28.0	25.0	17.0	8.0
	Kiwere	93	2.2	6.5	17.2	31.2	43.0
	Magozi	97	6.2	8.3	25.8	27.8	32.0
Rain-fed	Mkoba	66	65.2	3.0	13.6	0.0	18.2
	Silalatshani	94	42.6	4.3	23.4	2.1	27.7
	Kiwere	70	2.9	8.6	12.9	27.1	48.6
	Magozi	59	6.8	5.1	27.1	27.1	33.9
Irrigated crops	Mkoba	68	67.7	1.5	14.7	0.0	16.2
	Silalatshani	99	51.5	2.0	22.2	2.0	22.2
	Kiwere	89	3.4	4.5	16.9	27.0	48.3
	Magozi	92	7.6	5.4	25.0	23.9	38.0

Cattle	Mkoba	42	42.9	11.9	11.9	7.1	26.2
	Silalatshani	77	18.2	5.2	26.0	11.7	39.0
	Kiwere	23	4.4	0.0	17.4	4.4	73.9
	Magozi	16	0.0	0.0	56.3	6.3	37.5
Small stock	Mkoba	61	55.7	16.4	13.1	1.6	13.1
	Silalatshani	95	48.4	16.8	21.1	4.2	9.5
	Kiwere	51	5.9	2.0	21.6	7.8	62.8
	Magozi	43	9.3	16.3	23.3	9.3	41.9

Note: The sample sizes for 25 Setembro and Khanimambo schemes were too small (25 and 9 respectively) to include.