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"We're in this together": Changing intra-household decision making for more cooperative smallholder farming

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"We're in this together": Changing intra-household decision making for more cooperative smallholder farming

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Table of Contents

Abstract

Conceptualising smallholder farming households as collective action institutions, that make interrelated decisions about investment, resource use and allocation in a common household farm, may contribute to understanding widely observed uncooperative outcomes, such as yield gaps, gender gaps in productivity, suboptimal or Pareto inefficient sustainable intensification and climate change adaptation. We examine the relation between participatory intra-household decision making – as a set of 'rules of the game' that reduces information and bargaining power asymmetries – and cooperative, i.e. more efficient, sustainable and equitable, outcomes in smallholder coffee farming households in Uganda. We find experimental evidence that participatory decision making is positively related to investments in the common household farm. Consumption behaviour however is not fairer nor more sustainable. Participatory decision making is associated with more cooperative actual outcomes such as greater investment in sustainable intensification, consideration of women's interests, fairer reproductive intra-household labour division, more balanced control over cash crop income and improved livelihoods.

1. Introduction

In this article we will explore to what extent intra-household decision making about production and resource allocation that better guarantees symmetric information and equal involvement in decisions is related to more sustainable, efficient and equitable household farming in sub-Saharan Africa. We specifically look at smallholder coffee farming households in western Uganda.

Agricultural production in East Africa, which is characterised by household farming systems, does not score high in terms of efficiency or sustainability. There are significant food and cash crop yield gaps, including coffee, partly due to biophysical challenges. Management issues often aggravate the gaps (Tittonell & Giller, 2013; Wang et al., 2015). Yield gaps are likely to widen due to climate change (Blanc, 2012). Yet, adoption rates of sustainable intensification measures and climate change adaptation practices are sub-optimal (Boko et al., 2007; Goh, 2012; Tittonell & Giller, 2013). There is also increasing evidence of significant gender productivity gaps, in part linked to imbalanced intra-household allocation of time and resources (i.a. Aguilar, Carranza, Goldstein, Kilic, & Oseni, 2014; Ayalew, Bowen, Deininger, & Duponchel, 2015; McGee & Backiny-Yetna, 2015); in addition to gender specific responses to climate change which are not always optimal from a household perspective (Goh, 2012; Haglund et al., 2014). Such gender gaps are likely to contribute to inefficient and unsustainable household farming. At the same time, there is overwhelming evidence of intra-household inequalities with regard to resource allocation, expenditure, health care and nutrition (Fafchamps, Kebede, & Quisumbing, 2009; Quisumbing & Maluccio, 2000). Concurrently, there is experimental evidence, including from rural Uganda, that spouses in agricultural households frequently do not maximize the potential from cooperation or act opportunistically (i.a. Iversen, Jackson, Kebede, Munro, & Verschoor, 2011).

These observations suggest that farming households may not always behave in cooperative ways. While a multitude of challenges at different institutional levels encumber sustainable, efficient and equitable outcomes of household farming and appropriate adaptation to climate change, it is increasingly acknowledged that some of the challenges are situated at the intra-household level and that these should be explored more in-depth (Doss & Meinzen-Dick, 2015; Narayan, 2015). Insights into such intra-household challenges are essential parts of the puzzle to achieve agricultural development that is sustainable, gender equal, resilient and adaptive to climate change.

In a household farming system the household is the entity making interrelated decisions about (investments in) production and consumption of the resources (re)generated through the household farm (i.a. Muller (1994) and Morduch (2005) in the development economics literature and Fresco and Westphal (1988) in the farming systems literature). There is evidence that each household member has his/her own utility function with different preferences and different abilities to impact outcomes (Alderman, Hoddinott et al. 2003; Doss and Meinzen-Dick 2015). If preferences are different, there will be bargaining between household members and the weight of decisions of each household member about production and consumption will depend on his/her bargaining power, control over assets, labour and other resources (Agarwal, 1997; Doss, 2013; Quisumbing, 2003).

While cooperative bargaining models foresee households to come to cooperative solutions or else members would have opted out, non-cooperative models assert that intra-household decision making is not necessari-

ly cooperative nor Pareto efficient (Doss & Meinzen-Dick, 2015; Iversen et al., 2011). Doss and Meinzen-Dick (2015) argue that collective action dilemmas arise when members of agricultural households - with different control over resources, different preferences, roles and constraints - make decisions making about production and consumption. These dilemmas resemble the interrelated dilemmas of provision and appropriation from common pool resources (CPR). On the one hand, individual CPR users may underinvest in provision because they would individually bear the investment costs but only (expect to) receive a share of the benefits (provision dilemma). On the other hand, individual CPR users may overconsume and deplete the resource stock when they can benefit from using the resource while bearing only a portion of the costs related to overuse (appropriation dilemma) (Doss & Meinzen-Dick, 2015; Ostrom, 1990).

Doss and Meinzen-Dick (2015) therefore suggest conceptualising the household as a collective action institution, in parallel with the theory on CPR, rather than seeing the household as a unit or as a set of separate individuals. A key insight of the CPR theory is that cooperative outcomes are possible with appropriate institutions (Ostrom, 1990). Institutions as 'rules of the game' allow avoiding overexploitation and distributive conflicts and are typically based on trust, (reciprocity) norms and mutual commitment (Cardenas & Carpenter, 2008; Ostrom, 1990). Some key features that have been found to be conducive for efficient and sustainable CPR governance include communication, symmetric information, homogeneity of the user group, symmetric costs and benefits (Baland & Platteau, 1998; Ruttan, 2008). The experience of less opportunistic provision and appropriation strengthens incentives for cooperative behaviour; as does more involvement in rule and decision making (Agrawal, 2001). Skewed power relations have been found to contribute to unequal distribution and unsustainable use of CPR (Lecoutere, D'Exelle, & Van Campenhout, 2015).

Extrapolating the theory and evidence on collective action in CPR settings leads us to assume that the 'rules of the game' that govern intra-household decision making about production and consumption of household commons can be decisive for whether the household reaches cooperative outcomes. There is experimental evidence that cooperative outcomes are more likely in the absence of asymmetric information between spouses and in the absence of spousal heterogeneity, like differences in endowment, education level, occupation, age (Iversen et al., 2011). Other experimental studies tested the effect of communication, allocation rules and responsibilities, the composition of the group (e.g. polygamous versus monogamous households) or prevalent gender roles (e.g. North India with limited versus South India with more female autonomy) (Iversen et al., 2011; Kebede, Tarazona, Munro, & Verschoor, 2014; Mani, 2008; Munro, Kebede, Tarazona-Gomez, & Verschoor, 2010; Munro, Kebede, Tarazona-Gomez, & Verschoor, 2014). The findings are not always clear-cut as in many cases the effects interact with the context and social norms defining gender roles or intra-household decision making (Ashraf, 2009; Iversen et al., 2011).

Furthermore, theory and evidence on intra-household bargaining shows that women's bargaining power affects the outcomes of household decisions (Doss & Meinzen-Dick, 2015). Limited bargaining power of women leads to sub-optimal allocation of labour or men capturing benefits from new agronomic techniques (Doss, 2013). Although intra-household bargaining seems likely to influence the adoption of new agricultural technologies, this has received little attention in the literature (Doss, 2013). Agarwal (1997) argues that inequitable outcomes are less likely when women participate more effectively in intra-household decision making.

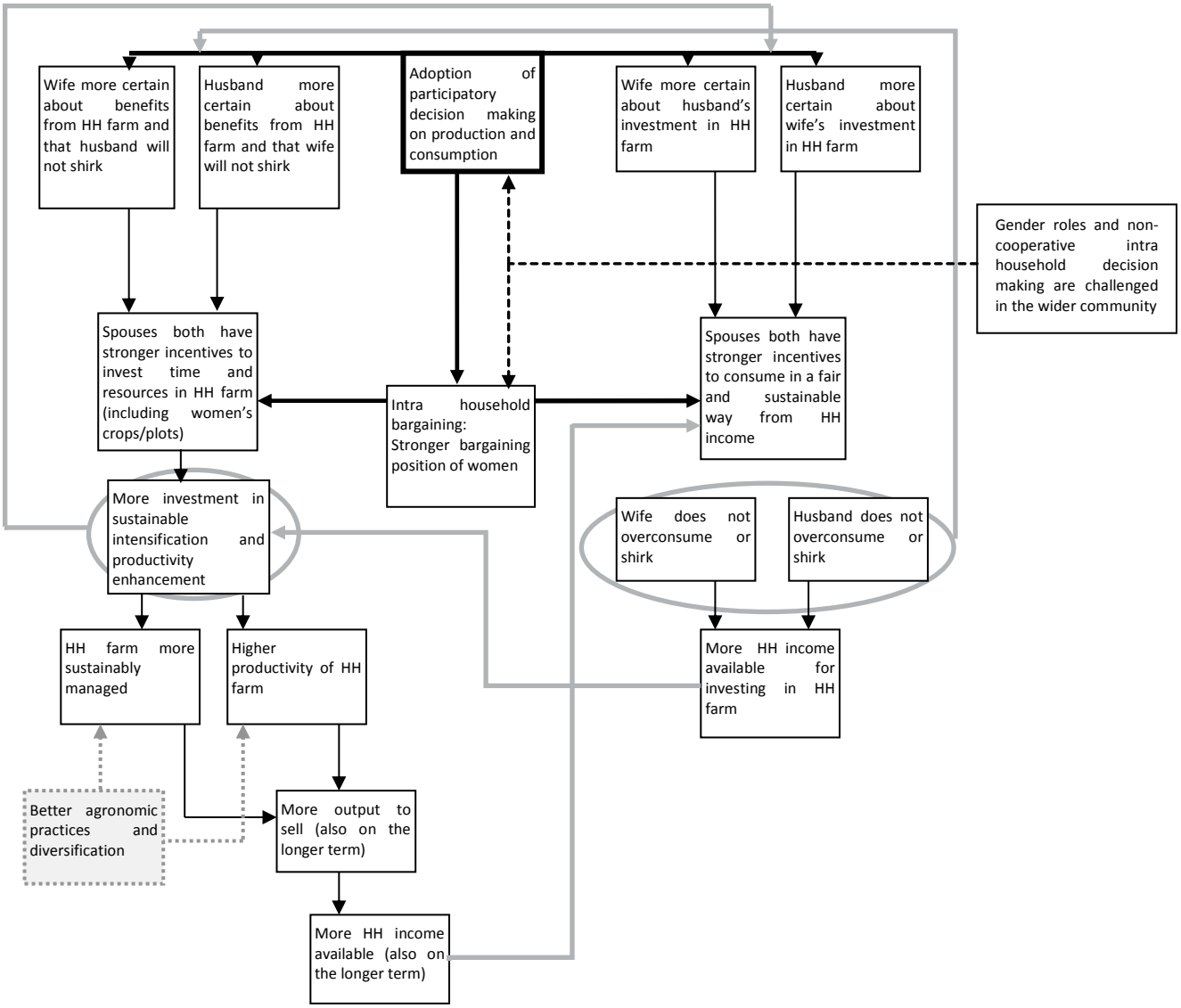
In this article we investigate if cooperative outcomes are more likely when agricul-

tural households, as collective action institutions, adopt favourable 'rules of the game'. Such 'rules of the game' can consists of a manner of intra-household decision making that is likely to reduce information asymmetries between household members, ease power imbalances and increase the involvement of each member in rule and decision making. In particular we examine the relation between cooperative outcomes and participatory intra-household decision making. Intra-household decision making is considered to be participatory when household members, especially spouses, consult with each other and collaborate on issues related to production, resource allocation and consumption in the household farm. In line with CPR theory, more cooperative outcomes would entail more sustainable, efficient and equitable household farming systems (Agrawal, 2001; Ostrom, 1990).

To investigate this we will address two questions: First, is provision and appropriation behaviour in farming households who have a participatory way of intra-household decision making more cooperative in an experimental setting? We will test the following hypotheses by means of a framed economic experiment, typically used to study provision and appropriation dilemmas in CPR settings: Men and women in couples who adopted participatory decision making contribute more to investments in the household commons (*Hypothesis 1*) and contribute more equally (*Hypothesis 2*). They also consume in a more sustainable (*Hypothesis 3*) and fair way (*Hypothesis 4*) from the household income they generated through investment in the experiment.

The second question revolves around the relation between participatory intra-household decision making and the sustainability, efficiency and equitability of the outcomes of intra-household provision and appropriation behaviour. We will test the following hypotheses based on an individual survey conducted separately among husbands and wives: Men and women in couples who adopted participatory decision making invest more in sustainable intensification (*Hypothesis 5*). Women's interests are more taken into account (*Hypothesis 6*), intra-household time allocation to productive and reproductive tasks is fairer (*Hypothesis 7*) and there is a more balanced control over farm income in these couples (*Hypothesis 8*). There is a greater increase in income (returns of investment) and less food insecurity over time among couples who adopted participatory decision making (*Hypothesis 9*).

Figure 1 Pathways of change



The hypotheses are based on the fact that spouses, whom adopted participatory decision making, are better informed about the household investment and expenditure needs, about each other's contributions to farm production and about each other's consumption from the household income. Reduced uncertainty is expected to weaken incentives for opportunistic behaviour (The pathways of change are visualised in Figure 1 black line). Incentives for cooperative behaviour are likely to be further strengthened by greater involvement of all in rule and decision making and by the repeated experience of others' less opportunistic provision and consumption behaviour (Figure 1 grey line) (Agrawal, 2001). As a result, we expect a more sustainably managed and more productive household farm with more output to sell and a higher household farm income, also in the long run. A virtuous circle of more household income remaining for investment and more sustainable and fair consumption of that income is expected to lead to improved household wellbeing, translating into enhanced food security. Through more effective involvement of women in decision making inequitable levels of investment and consumption are likely to be averted (Agarwal, 1997); with a more balance allocation of household labour and more attention for food production as a result.

Finally, challenging the prevailing norms and rules governing intra-household decision making is expected to be conducive for the acceptance of participatory planning and decision making about household farming and income expenditure and could have additional beneficial effects on cooperative behaviour and outcomes (Figure 1 dotted line) (Kabeer, 1999). However, we will not directly measure such effects.

2. The Hanns R. Neumann Stiftung gender program targeted at smallholder coffee producers

The study concentrates on smallholder producers of Arabica coffee on the slopes of the lower Rwenzori Mountains in Kasese district in western Uganda, whom are connected to the Hanns R. Neumann Stiftung (HRNS).[1] The Kasese branch of HRNS, set up in 2012, works with 312 farmer groups, composed of approximately 25 coffee producing households, clustered in 10 depot centres. The Kasese branch of HRNS organizes training in agronomic practices to improve productivity and quality of coffee for all its farmer groups. It runs a gender program since August 2012. HRNS has gradually rolled out the gender program in Kasese district among its farmer groups, not in a random way but rather by geographical clusters.

The objective of the gender program is sustainably enhancing economic profitability of household farming and improving livelihoods while ensuring equitable access for men and women to opportunities and resources (HRNS 2014). Where the gender program is implemented, HRNS conducts couple seminars during which the gender division of labour, control over resources for production and benefits are discussed. Customs and norms about gender roles are problematized. By using change agents as role models and awareness raising during community events, HRNS aims to challenge the prevailing norms and enhance the acceptance of participatory decision making.

After participating in a couple seminar, couples can sign up to become change agents. HRNS then intensively coaches these change agent couples on participatory planning and decision making. The change agent couples receive training, are mentored by the gender officer of HRNS and are assisted in jointly drafting a plan and budget for agricultural production and for household expenditures during quarterly home visits. We call men and women in these couples the Direct Change Agents (DCA).

In Kasese, HRNS allows DCA to recruit Indirect Change Agents (ICA). The ICA may have participated during progress meetings with DCA and in couple seminars but did not receive the change agent coaching nor the home visits. Other people in farmer groups where the gender program is implemented may have been exposed to awareness raising about participatory decision making or have interacted with change agents.

3. Research methods

Data was collected in April 2015. We identified farmer groups in which HRNS had run the gender program for more than one year to allow repeated interactions contributing to changing behaviour. From these groups, we purposively selected change agent couples and randomly selected non-change agent couples. Other non-change agent couples were randomly selected from farmer groups where HRNS had not implemented the gender program. All farmer groups received the same agronomic trainings on coffee production, (diversified) agricultural production, post-harvest handling of coffee and marketing by HRNS. Figure 2 locates the farmer groups in our sample with and without the gender program.

[1] In Kasese district HRNS works with Arabica coffee producers, in other areas in Uganda they work with smallholder producers of Robusta coffee.

Figure 2 Map of data collection sites

	Villages	No (NG) Gender program (G)	Altitude
A	Wsewanaba (Kabatunda)	G	1436 m
B	Katebe	G	1272 m
C	Nyakabingo	G	1600 m
D	Isule	NG	1473 m
E	Kyabarungira	NG	1339 m
F	Maliba	G	1299 m
G	Mpumuro	NG	1647 m
H	Katooke	G	1200 m
I	Kasese		987 m

We conducted a framed field experiment with husbands and wives in change agent and non-change agent couples. The first stage of the experiment mimicked dilemmas spouses face when they decide how much of their available resources to invest in the common household farm at the beginning of the agricultural season. In practice, per experiment session, we provided wife and husband of each couple a box containing 2000 UGX, i.e. ten coins of 200 UGX, representing their available resources. We did not reveal this but informed the participants each box contained between 0 and 4000 UGX.[2] Wives and husbands, seated next to each other, were instructed to individually decide, without communicating, how much of their available resources to invest in the household farm and how much to use for other purposes. They left the amount for investment in the box and put the remainder in their pocket which allowed them to actually use it for other purposes after the experiment.

Before the investment decision, we explained participants that returns to investment, amounting to 10%, 30% or 50%, would be added per couple's total investment. Random assignment of low or high returns to investment mimicked their unpredictability as, in reality, these depend on climatic, agronomic and other conditions.

The second stage of the economic experiment imitated dilemmas wife and husband face when, at the end of the season, they decide how much they will individually use from the household income generated through the household farm. That income is the sum of their investments and the returns to investment. We privately disclosed the household income to wife and husband of each couple by means of a decision card. Wife and husband then decided individually, without communicating, how much to individually consume from the household income by writing it on the decision card.[3] The participants were informed that amount would remain secret, also for their partner, and would be paid out to each individual after the experiment. Participants understood that if the aggregate consumption by wife and husband was smaller

[2] Asymmetric information about initial individual endowment is necessary for investment decisions to be truly private (Iversen et al., 2011).

[3] Illiterate participants were individually assisted by the research assistant.

than the total household income, the remainder would be household savings, which, in the experiment like in reality, could be used later, for instance for investments in the next season. If the aggregate consumption was larger than the total household income, pay-offs would be proportional.

We did not disclose the number of rounds but explained that the first and second stage of the experiment could be repeated to represent consecutive seasons. In practice, we conducted the first and second stage of the experiment only once. After the experiment, participants privately answered to two individual post experiment questions.

We conducted 27 sessions of experiments each with a maximum of 6 couples. In total 155 couples participated. On average participants took 2216 UGX home, maximum 3729 UGX and minimum 500 UGX (i.e. the sum of the amount not invested in the first stage and the amount consumed in the second stage).[4] Respectively 89% DCA and 88% non DCA men, 83% DCA and 78% non DCA women thought investment decisions in the experiment resembled real household farm investment decisions a lot or to some extent. Respectively 84% DCA and 83% non DCA men, 68% DCA and 74% non DCA women found there was a lot or some resemblance between decisions about the use of the household farming income in the experiment and in reality.

We individually interviewed all men and women whom participated in the experiment (N=310). We collected information on individual socio-economic characteristics, income and assets, farming systems, individual adoption of agronomic practices, intra-household control over income and household characteristics.

Ex-post, we decided to exclude ICA from our sample. This small sub-sample did not receive the intensive coaching on participatory decision making like the DCA but could not be treated as non-change agents either as their inclination towards adopting participatory decision making may have been stronger. We also excluded outliers, more particularly couples in which the wife is (more than) 35 years younger than the husband and the husband (more than) 15 years younger than the wife. The operational sample we retained includes 135 couples, including 36 change agent couples and 99 non-change agent couples.

We can assume change agent couples are more likely to have adopted participatory intra-household decision making, both as a result of the coaching and because of their initial interest in it (self-selection). To investigate the relation between participatory intra-household decision making and cooperative household farming we will compare (spouses in) change agent (DCA) couples with non-change agent (non DCA) couples.

Note that the aim of this study is not to assess the extent to which change can be attributed to the HRNS gender program. HRNS did not assign the intensive guidance about participatory decision making to randomly selected change agents. By definition change agents are self-selected. Hence it is likely that change agents had a greater interest or willingness to adopt participatory intra-household decision making than those who did not subscribe to the change agent coaching.

To make change agent couples and non-change agent couples in our sample more 'comparable', we matched them in our operational sample based on the propensity score. The propensity score (PS) expresses the conditional probability of being in the treated group given a set of covariates, i.e. couple characteristics in this case (Rosenbaum & Rubin, 1983). We es-

[4] As a reference, the average monthly household income in mid-west Uganda in 2012/2013 was 370,000 UGX (UBOS 2014).

timated the propensity score on the basis of the age of the husband, the difference in age and in education level between wife and husband and the size of the farm in acres as declared by the husband, using 1:2 nearest neighbour matching without replacement. Farm size was used as a proxy for wealth. We included age difference and education difference because there is a positive relation between spousal assortative matching and cooperative outcomes (Iversen et al., 2011). Besides, larger differences in education coincide with higher education levels of the husband, as women are generally lowly educated. Higher education levels of men in turn are associated with more gender equitable attitudes (Barker et al., 2011). In the matched operational sample we retain 36 change agent couples and 72 non-change agent couples; we dropped 27 un-matched non-change agent couples.[5]

Throughout the analyses, we used inverse probability of treatment weighting (IPTW) to balance the observations in such a way that the chance the couples in our sample are change agents is independent of the (observable) covariates conditional on the PS (Rosenbaum & Rubin, 1983). In IPTW, each couple's weight is equal to the inverse of the probability of the couple having 'received the treatment' (i.e. be a change agent couple) conditional on their observed covariates (Austin & Stuart, 2015; Hirano & Imbens, 2001). For analyses of husbands' or wives' data we assigned their couple's weight.

4. Results

We first examine investment and consumption behaviour in the experiment of husbands and wives in couples whom adopted participatory decision making (DCA) and whom did not (non DCA) to test hypotheses 1 to 4. Then, we analyse the survey data to look for relations between participatory decision making and outcomes of investment behaviour and consumption behaviour in reality and test hypotheses 5 to 9.

4.1. Intra-household investment and consumption behaviour in the experiment

4.1.1. Testing hypothesis 1: Men and women in couples who adopted participatory decision making contribute more to investments in the household commons

We first compare total contributions to investments in the household commons, i.e. the sum of contributions by husband and wife, in DCA and non DCA couples. To do so we use an IPTW interval regression analysis with a dummy variable taking the value 1 for DCA couples, 0 otherwise (Model A Table 1). The significant positive coefficient of the DCA dummy demonstrates that total contributions by DCA couples are significantly higher than those by non DCA couples.

[5] In Annex A we present the assessment of balance of the PSM.
We list descriptive statistics of individual and household characteristics of change agents (DCA) and non-change agents (non DCA) in our matched operational sample in Annex B.

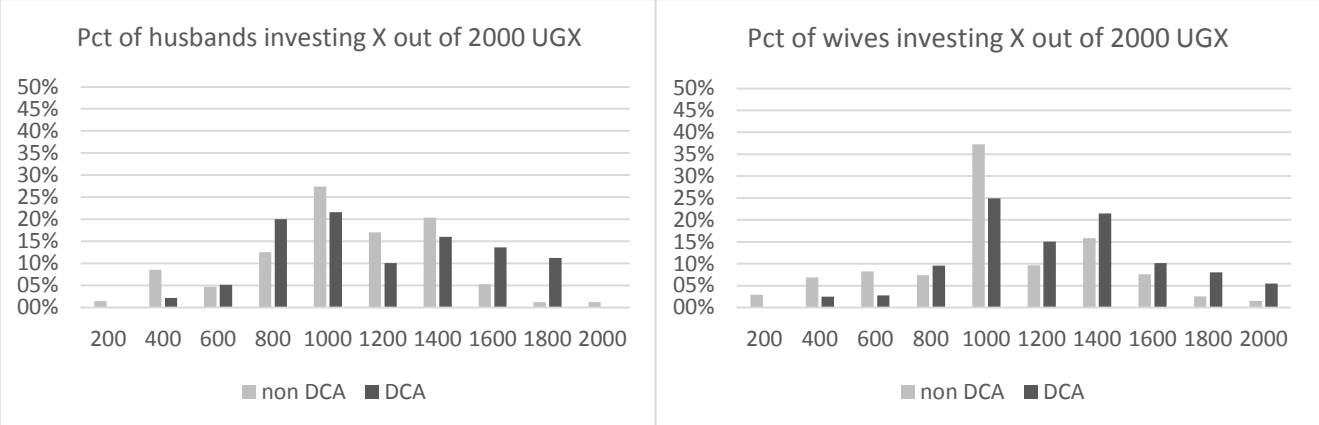
Table 1: Investment behaviour in the experiment

Dependent Variable	Total contribution by couple				Contribution to investment by husband				Contribution to investment by wife				Difference contribution husband and wife			
	IPTW average	S.E.			IPTW average	S.E.			IPTW average	S.E.			IPTW average	S.E.		
DCA	2433.5	104.9			1182.2	66.4			1251.4	65.0			-69.2	79.1		
Non DCA	2114.3	73.9			1062	42.5			1051.7	45.7			11.0	48.2		
	IPTW interval regression Model A				IPTW interval regression Model B				IPTW interval regression Model C				IPTW general linear model Model D			
	B	S.E.	z	Sig.	B	S.E.	z	Sig.	B	S.E.	z	Sig.	B	S.E.	t	Sig.
(Constant)	2114.3	73.9	28.61	.000***	1062.7	42.5	22.66	.000***	1051.7	45.7	20.82	.000***	11.0	48.2	.228	.820
DCA dummy	319.2	128.3	2.49	.013*	119.5	78.8	1.52	.129.	199.7	79.5	2.51	.012*	-80.2	92.6	-.866	.389
N (unweighted)																
DCA	36				36				36				36			
Non DCA	72				72				72				72			
N (weighted)																
DCA	136.7				136.7				136.7				136.7			
Non DCA	99.5				99.5				99.5				99.5			
R^2													.008			
Log-likelihood	-595.98				-1731.05				-1735.19							
Chi^2	6.19				2.30				6.31							
Prob > Chi^2	.013				.129				.012							

*Significance levels[6]: ***=0.001; **=0.01; *=0.05; °=0.1; .=0.15*

Next, we examine investment behaviour by husbands and wives. Figure 3 shows that about one third of non DCA husbands invests 1000 UGX (which is half of the initial endowment). Relatively large proportions of DCA husbands invest more than 1000 UGX. There is a strong tendency of women to invest half of the available 2000 UGX but particularly DCA wives are more likely to invest higher amounts.

Figure 3 IPTW percentages of husbands/wives in DCA and non-DCA couples per amount invested in the experiment



We found a weakly significant difference (0.15) in amounts invested in the household commons between DCA and non DCA husbands (Model B in Table 1). The contributions to investment in the household commons of DCA wives are significantly higher than those by non DCA wives (significant positive DCA dummy in Model C Table 1).

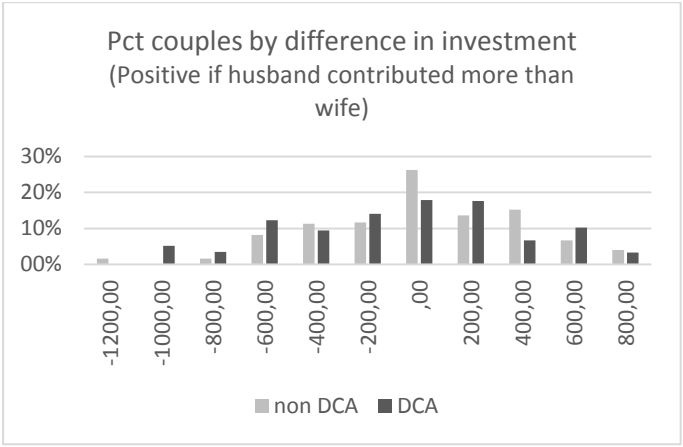
The evidence confirms that couples and women in couples who adopted participatory decision making contribute more to investments in the household commons in the experiment.

[6] As we deal with small sample sizes we will at times mention differences at more liberal significance levels up to 0.15, while being wary that the chance of erroneously rejecting a true null hypothesis increases (Peers, 2006 p149).

4.1.2. Testing hypothesis 2: Men and women in couples who adopted participatory decision making contribute more equally to investment in the household commons

To analyse the relation between participatory decision making and equal investments by spouses, we first look at (weighted) frequencies of DCA and non DCA couples by level of difference in investments (presented in Figure 4). A positive difference indicates the husband contributed a higher amount than his wife. A relatively high percentage of non DCA couples invest equal amounts, in fact many non DCA husbands and wives both invest 1000 UGX (see Figure 3). Model D in Table 1 shows that, on average, spousal investment differences are equal to zero both in non DCA and in DCA couples (insignificant coefficient of the intercept and the DCA dummy). Hence, the evidence does not support hypothesis 2.

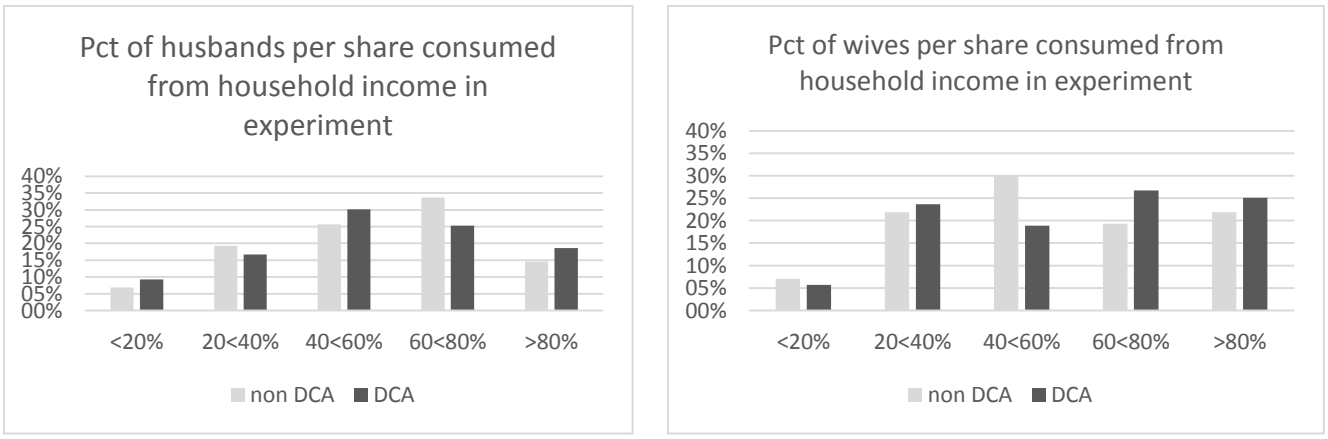
Figure 4 IPTW percentages of DCA and non DCA couples by difference in investment between husband and wife



4.1.3. Testing hypothesis 3 and 4: Men and women in couples who adopted partici patory decision making consume in a more fair and sustainable way from the household income

First, we look at the fairness of consumption in relation to participatory decision making. To do so, we examine the share husbands and wives in DCA and non DCA couples consume from the total household income they generated through investment in the experiment (i.e. the sum of contributions by husband and wife in stage one plus returns to investment). Figure 5 shows that, while most DCA husbands consume about half of the available household income, most non DCA husbands consume more than half. A somewhat different pattern emerges for wives: most DCA wives consume more than half and most non DCA consume about half.

Figure 5 IPTW percentages of husbands/wives in DCA and non-DCA couples per share consumed of the available income



In model B (resp. model E) in Table 2 we scrutinize differences in shares of income consumed between DCA and non DCA husbands (resp. wives) while controlling for the amount of total household income available, assuming this could influence consumption behaviour. We included a dummy variable which takes the value 1 if the total household income is medium high, more specifically between 2601 and 3299 UGX.[7] In model C (resp. model F), we control for one's own contribution to investment by including a dummy variable taking the value 1 if it was medium high, i.e. between 800 and 1200 UGX.

The negative significant coefficient of the medium investment dummy in Model F shows us that wives, regardless of being change agents or not, tend to take smaller shares when their contribution to the household commons was medium high. Whether the total household income was medium high or not does not make a difference for shares consumed by wives; not for DCA nor non DCA wives (insignificant coefficients in model E).

If one would allow a very liberal significance level of 0.178, one could argue that DCA husbands consume smaller shares than non DCA husbands when the total household income is medium high (negative significant coefficient for the interaction term of the DCA and medium household income dummies in model B). There are otherwise no indications of smaller shares consumed by DCA husbands (DCA dummy not significant in model B, nor model C); nor from a relation with the amount contributed (dummy for medium investment by husband is insignificant in model C).

[7] We categorised total household incomes of the second tertile of the complete weighted sample as a medium level total household income. The first tertile has total household income between 600 and 2600 UGX and the third tertile between 3300 and 5400 UGX.

Table 2: Shares of income consumed in the experiment

Dependent Variable	Share consumed by husband				Share consumed by husband				Share consumed by husband				Share consumed by wife				Share consumed by wife				Share consumed by wife			
	IPTW average	S.E.											IPTW average	S.E.										
DCA	0.564	0.044											0.627	0.062										
Non DCA	0.558	0.027											0.559	0.030										
	IPTW GLM Model A				IPTW GLM Model B				IPTW GLM Model C				IPTW GLM Model D				IPTW GLM Model E				IPTW GLM Model F			
	B	S.E.	t	Sig.	B	S.E.	t	Sig.	B	S.E.	t	Sig.	B	S.E.	t	Sig.	B	S.E.	t	Sig.	B	S.E.	t	Sig.
(Constant)	.558	.027	20.589	.000***	.565	.032	17.396	.000***	.567	.045	12.687	.000***	.559	.030	18.479	.000***	.575	.040	14.442	.000***	.615	.046	13.266	.000***
DCA dummy	.006	.052	.108	.914	.037	.061	.611	.543	.004	.090	.048	.962	.067	.069	.978	.330	.048	.066	.726	.470	-.010	.088	-.111	.912
Medium total HH income					-.024	.059	-.404	.687									-.053	.056	-.944	.347				
Medium total HH income *DCA					-.138	.101	-1.357	.178									.069	.213	.323	.747				
Medium contribution husband									-.015	.056	-.271	.787												
Medium contribution husband *DCA									.001	.105	.008	.993												
Medium contribution wife																					-.102	.060	-1.701	.092°
Medium contribution wife *DCA																					.146	.138	1.063	.290
N (unweighted)																								
DCA	36				36				36				36				36				36			
Non DCA	72				72				72				72				72				72			
N (weighted)																								
DCA	136.7				136.7				136.7				136.7				136.7				136.7			
Non DCA	99.5				99.5				99.5				99.5				99.5				99.5			
R²	.000				.050				.001				.011				.014				.025			

*Significance levels: ***=0.001; **=0.01; *=0.05; °=0.1; .=0.15*

Next, we look at the sustainability and fairness of consumption by the couple. Our indicator for overconsumption is the difference between aggregate consumption of spouses and the total household income (including returns to investment). It is positive in case of overconsumption. The IPTW general linear model (GLM) estimates of overconsumption do not show any relation with being change agents or not (insignificant DCA dummy); nor with levels of total household income available (insignificant medium total household income dummy) (Model A Table 3).

Table 3 Overconsumption and fairness of consumption in the experiment by couples

Dependent Variable	Overconsumption				Fair consumption			
	IPTW average	S.E.			IPTW frequency			
DCA	-660.54	281.81			22.6%			
Non DCA	-319.40	128.01			34.2%			
	IPTW GLM Model A				IPTW logistic regression Model B			
	B	S.E.	t	Sig.	B	S.E.	t	Sig.
(Constant)	-372.0	164.4	-2.263	.026*	-1.027	.325	-3.159	.002**
DCA dummy	-438.3	373.3	-1.174	.243	-.600	.616	-.973	.333
Medium total HH income	172.8	249.3	.693	.490	1.115	.541	2.063	.042*
Medium total HH income *DCA	451.3	612.3	.737	.463	.193	1.021	.189	.850
N (unweighted)								
DCA	36				36			
Non DCA	72				72			
N (weighted)								
DCA	136.7				136.7			
Non DCA	99.5				99.5			
R²	.038				.109 (Nagelkerke)			

*Significance levels: ***=0.001; **=0.01; *=0.05; °=0.1; .=0.15*

We constructed a dummy variable taking the value 1 if both husband and wife consumed a share higher than 30% but lower than 70% to indicate (relatively) fair consumption by the couple. The positive coefficient of the medium total household income dummy in model B

in Table 3 demonstrates that the likelihood of fair consumption by couples is higher at medium levels of total household income as compared to low or high levels. This is the case for both DCA and non DCA couples.

Being change agents or not apparently does not relate to sustainability nor to fairness of consumption from the income generated through the household commons.

4.2. Actual outcomes of intra-household investment and consumption behaviour

4.2.1. Testing hypothesis 5: Men and women in couples who adopted participatory decision making invest more in sustainable intensification

We specifically look into adoption rates of sustainable intensification practices for coffee production as outcomes of intra-household investment behaviour. We concentrate on couples in which wife and husband agree that the most important cash crop in season B is Arabica coffee and in which the wife declared the husband manages the plot or they jointly do it, which is the most common situation.[8] That leaves us with an unweighted sub-sample of 97 couples.

Table 4 Adoption rates of sustainable intensification by men, personally or jointly managing coffee as the most important cash crop

	Non DCA	DCA
Improved seedlings	39.4%	52.9%
Trenches	91.8%	88.9%
Intercropping	46.7%	59.9%
Mulch	50.0%	42.3%
Compost	13.8%	27.5%
Chemical fertiliser	4.7%	13.2%
Herbicides	12.3%	13.3%
Pesticides	6.0%	13.5%
Shade trees	58.8%	76.6%
Pruning	77.4%	78.4%
Stumping	22.2%	37.1%
Weighted N	91.5	119.5

We present weighted percentages of men in DCA and non DCA couples who adopted a particular sustainable intensification practice in Table 4.[9] We further explored adoption rates that are markedly different between DCA and non DCA husbands using IPTW logistic re-

[8] Season B is the cropping season that coincides with the rainy season from October to December with harvests in January up to February.

We defined a person who manages the plot (crop) as the person who makes the majority of agricultural decisions with regard to the plot (crop) (such as what input to use, what should be done and who should do this, when to weed, when to harvest). It does not mean doing the work on the plot.

[9] For an overview of recommended coffee management practices in Uganda see (Bongers et al., 2015). Most of the practices considered here are recognized as sustainable intensification practices, with (some) potential to increase resilience to climate change effects.

Improved seedlings imply coffee seedlings come from certified nurseries. *Trenches*, including terracing, are applied as a soil and water conservation measure. With *intercropping* we refer to the practice of simultaneously growing crops with complementary nutrients. Applying *mulch* is a moisture and nutrient conservation measure and can serve as weed control. *Compost* is the practice whereby manure or household residue compost is applied to add nutrients to the soil. With *fertiliser, herbicides, pesticides* we refer to application of inorganic products to add nutrients, control weeds or pests. *Pruning* is a coffee specific agronomic practice that consists of removing excess berries to ensure a balanced crop/leaf ratio. *Stumping* rejuvenates old coffee trees.

We consider the practice as adopted if the husband declared he applied it to the entire or relatively large part of the coffee plantation.

gression analysis (Table 5).[10] The positive significant coefficients of the DCA dummy in model D, G and H indicate that husbands in DCA couples are more likely than those in non DCA couples to have adopted respectively composting, the planting of shade trees and stumping as sustainable intensification practices (significance level of 0.15). At a very liberal significance level of 0.171, one could say DCA husbands are more likely to have applied chemical fertiliser than non DCA husbands.

Table 5 The likelihood of adopting sustainable intensification measures for coffee as the most important cash crop (by men)

Dependent Variable	Improved seedlings				Intercropping				Mulch				Compost				Fertiliser				Pesticides				Shade trees				Stumping			
	IPTW logistic regression Model A				IPTW logistic regression Model B				IPTW logistic regression Model C				IPTW logistic regression Model D				IPTW logistic regression Model E				IPTW logistic regression Model F				IPTW logistic regression Model G				IPTW logistic regression Model H			
	B	S.E.	t	Sig.	B	S.E.	t	Sig.	B	S.E.	t	Sig.	B	S.E.	t	Sig.	B	S.E.	t	Sig.	B	S.E.	t	Sig.	B	S.E.	t	Sig.	B	S.E.	t	Sig.
(Constant)	-.429	.254	-1.688	.095°	-.130	.249	-.523	.602	-.002	.248	-.007	.994	-1.834	.362	-5.063	.000***	-3.002	.595	-5.047	.000***	-2.750	.519	-5.300	.000***	.357	.253	1.414	.161	-1.254	.304	-4.128	.000***
DCA dummy	.545	.453	1.203	.232	.530	.453	1.169	.245	-.309	.454	-.680	.498	.864	.562	1.538	.127.	1.116	.809	1.381	.171	.893	.754	1.185	.239	.827	.518	1.596	.114.	.727	.488	1.488	.140.
N (unweighted)																																
DCA	31				31				31				31				31				31				31				31			
Non DCA	66				66				66				66				66				66				66				66			
N (weighted)																																
DCA	119.5				119.5				119.5				119.5				119.5				119.5				119.5				119.5			
Non DCA	91.5				91.5				91.5				91.5				91.5				91.5				91.5				91.5			
R^2 (Nagelkerke)	.024				.023				.008				.043				.046				.032				.050				.037			

*Significance levels: ***=0.001; **=0.01; *=0.05; °=0.1; .=0.15*

Next, we analyse to what extent participatory decision making relates to the adoption of sustainable intensification practices for food crop production. We focus on households in which the wife declared that cassava is the most important food crop for the household and that she manages the crop herself or jointly with her husband, which is the most common situation.[11] As such, we retain 81 households in the unweighted sub-sample.

Table 6 Adoption rates of sustainable intensification among women, personally or jointly managing cassava as the most important food crop

	Non DCA	DCA
Improved seedlings	0.00%	0.00%
Trenches	24.64%	10.14%
Intercropping	65.39%	82.11%
Mulch	9.44%	8.79%
Compost	0.00%	0.00%
Chemical fertiliser	0.00%	0.00%
Herbicides	0.00%	0.00%
Pesticides	0.00%	0.00%
Weighted N	75.8	96.5

We present adoption rates of different sustainable agronomic practices by wives for cassava production in Table 6. In our sample, only trenches, intercropping and the application of mulch are applied to cassava. Table 7 shows us that, unexpectedly, women in DCA couples are less likely than women in non DCA couples to have adopted trenches for cassava production. But

[10] We tested to what extent respondents' contribution to investment in the experiment relates to investments in reality by including it in each of the models in Table 5 but it was never significant.

[11] Cassava is the most commonly cited most important food source in season B, followed by plantain.

they are more likely to have adopted intercropping, which is generally a widespread practice.

Table 7 The likelihood of adopting sustainable intensification measures for cassava as the most important food crop (by women)

Dependent Variable	Trenches				Intercropping			
	IPTW logistic regression Model A				IPTW logistic regression Model B			
	B	S.E.	t	Sig.	B	S.E.	t	Sig.
(Constant)	-1.118	.321	-3.486	.001**	.636	.286	2.223	.029*
DCA dummy	-1.063	.730	-1.456	.149.	.888	.587	1.512	.135.
N (unweighted)								
DCA	26				26			
Non DCA	55				55			
N (weighted)								
DCA	96.5				96.5			
Non DCA	75.8				75.8			
R^2 (Nagelkerke)	.062				.053			

*Significance levels: ***=0.001; **=0.01; *=0.05; °=0.1; .=0.15*

Evidence supports our hypothesis of a positive relation between participatory decision making and sustainable intensification of cash crop production, more particular of coffee (by men). The evidence of a relation with sustainable intensification of food crop production (by women) is weak and contradictory.

4.2.2. Testing hypothesis 6: Women's interests are taken more into account when couples have adopted participatory decision making

Assuming food crops are still mainly women's concern, more investments in intensification of food crop production in change agent couples could have been one indication that women's interest are more taken into account in these couples. Yet, in the previous section, we saw this is not really the case.

Joint or women ownership of the plots on which food or cash crops are grown would be another indication that women's interests are more considered. It is likely that women or joint ownership, especially if that view is shared by spouses, has a positive effect on the control women have over the plots and the claim women can lay on the benefits derived from the crops.

Yet, an IPTW logistic regression analysis on the sub-sample of couples in which spouses agree that the most important cash crop is Arabica coffee (N = 100 unweighted) does not indicate a significant relation between being change agents and the likelihood of (husband declared) joint ownership of coffee plots (Model A Table 8).[12] Then we looked at the sub-sample of couples in which spouses agree on the most important food crop in the household farm (mostly cassava, plantain in a few cases) (N = 95 unweighted). Agreed upon joint or woman ownership of the most important food crop plots is significantly more likely among DCA than non DCA couples (Model B Table 8).

[12] None of the husbands states the plot on which coffee is grown as the first cash crop is owned by their wife.

Table 8 The likelihood of joint ownership of cash crop plots and women/ joint ownership of food crop plots

Dependent Variable	Husband declared joint ownership of 1st cash crop plot				Agreed upon joint or wife ownership of 1st food crop plot			
	IPTW frequency				IPTW frequency			
DCA	37.3%				28.4%			
Non DCA	25.0%				15.1%			
	IPTW logistic regression Model A				IPTW logistic regression Model B			
	B	S.E.	t	Sig.	B	S.E.	t	Sig.
(Constant)	-1.099	.283	-3.889	.000***	-1.726	.364	-4.742	.000***
DCA dummy	.580	.469	1.235	.220	.798	.527	1.514	.133.
N (unweighted)								
DCA	32				33			
Non DCA	68				62			
N (weighted)								
DCA	121.6				127.2			
Non DCA	94.1				86.2			
R^2 (Nagelkerke)	.024				.037			

*Significance levels: ***=0.001; **=0.01; *=0.05; °=0.1; .=0.15*

4.2.3. Testing hypothesis 7: Time allocation to productive and reproductive tasks is fairer when couples have adopted participatory decision making

We asked respondents for the number of hours spent on various activities the previous day (of 12 hours). We distinguished activities related to farm production, harvesting, reproductive tasks (including cleaning, cooking, child care), care for cattle and small livestock, fetching water and/or firewood, post-harvest activities, daytime rest, leisure time, marketing and off farm income generating activities. Later in the interview, we asked respondents whether they (strongly) disagreed, (strongly) agreed or were neutral about the statement that 'farm work should be equally divided between spouses' and the statement that 'men should help their wives with domestic tasks like cooking, cleaning, washing, fetching water and firewood'.

If participatory decision making is associated with fairer intra-household time allocation, we expect that DCA husbands will spend more time on reproductive tasks, which include cleaning, cooking and child care, than non DCA husbands. We are also interested in husbands' opinion about helping with domestic tasks (dummy taking the value 1 if the husband (strongly) agrees and the relation with the time they spend on reproductive tasks.

The positive significant coefficient of the DCA dummy in model A in Table 9 shows the likelihood of agreeing with sharing domestic work is larger among DCA husbands. Model C demonstrates that husbands who agree men should help with domestic work seem to practice what they preach as their time spent on domestic work is significantly higher. Being part of a change agent couple does not directly increase the time husbands spend on domestic work (insignificant coefficient of the DCA dummy in model B); not even when they are of the opinion that men should help with domestic work (insignificant interaction effect of the DCA and opinion dummy in model D).

Table 9 Intra-household time allocation to reproductive and productive activities

Dependent Variable	Husband agrees men share reproductive tasks (HB_repro)				Husband time spent on reproductive activiities				Husband time spent on reproductive activiities				Husband time spent on reproductive activiities				Husband agrees equal sharing farm work (HB_farm)				Difference time farm work				Difference time farm work				Difference time farm work			
	IPTW frequency				IPTW average	S.E.											IPTW frequency				IPTW average	S.E.										
DCA	71.1 %				1.53	.35											90.7 %				-.57	.47										
Non DCA	56.2 %				1.36	.21											85.4 %				-.21	.36										
	IPTW logistic regression Model A				IPTW GLM Model B				IPTW GLM Model C				IPTW GLM Model D				IPTW logistic regression Model E				IPTW GLM Model F				IPTW GLM Model G				IPTW GLM Model H			
	B	S.E.	t	Sig.	B	S.E.	t	Sig.	B	S.E.	t	Sig.	B	S.E.	t	Sig.	B	S.E.	t	Sig.	B	S.E.	t	Sig.	B	S.E.	t	Sig.	B	S.E.	t	Sig.
(Constant)	.249	.239	1.040	.301	1.362	.208	6.557	.000***	.999	.188	5.319	.000***	1.145	.198	5.778	.000***	-1.769	.344	-5.140	.000***	-.213	.357	-.595	.553	.461	1.114	.413	.680	.405	1.094	.371	.712
DCA dummy	.652	.447	1.460	.147.	.167	.404	.413	.681					-.307	.382	-.803	.424	-.506	.643	-.788	.433	-.354	.591	-.599	.550					.118	2.303	.051	.959
HB_repro									.748	.369	2.025	.046*	.401	.395	1.015	.312																
DCA* HB_repro													.643	.700	.918	.361																
HB_farm																									-.993	1.158	-.857	.393	-.723	1.156	-.626	.533
DCA * HB_farm																													-.479	2.380	-.201	.841
N (unweighted)	36				31				31				31				36				36				36				36			
DCA																																
Non DCA	72				69				69				69				72				72				72				72			
N (weighted)	136.				116.				116.				116.				136.				136.				136.				136.			
DCA	9				9				9				9				9				9				9				9			
Non DCA	99.5				95.3				95.3				95.3				99.5				99.5				99.5				99.5			
R^2	.032(Nagelkerke)				.002				.04				.048				.013((Nagelkerke)				.004				.012				.015			

*Significance levels: ***=0.001; **=0.01; *=0.05; °=0.1; .=0.15*

Secondly, we analyze equality of time spent on farm work, which includes production and harvest activities, in relation to participatory decision making and in relation to one's opinion on equally sharing farm work. Our indicator is the difference in time spent on farm work by husband and wife. It is negative if the wife spends more time on farm work. Overall, intra-household time allocation on farm work seems rather equal and most men are of the opinion it should be shared equally. Still we checked for relations between the equality of time spent on farm work and the adoption of participatory decision making and opinions but found no significant relations (Model E to H Table 9).

4.2.4. Testing hypothesis 8: More balanced control over income among couples who adopted participatory decision making

To check this hypothesis we focus on income from coffee as the most important cash crop and we limit to households in which spouses agree coffee is the most important cash crop (N unweighted = 100). As there is only one case in which spouses agree that the wife controls (much) more than half or (almost) all of the income from coffee, we look at whether husband and wife agree that they jointly control (much) more than half or (almost) all of that income.[13] We constructed a dummy variable taking the value 1 if spouses agree on the latter. Results from a IPTW logistic regression analysis confirm that the likelihood on agreeing upon joint control of the lion share of the coffee income is positively related to being change agents, which supports our hypothesis (Table 10).

[13] We defined control over the income as making the (majority of) decisions on who can spend the money and on what the income will be spent.

Table 10 The likelihood of agreeing on joint control over the lion's share of income from coffee as the most important cash crop

Dependent Variable	Agreement on joint control of large share of coffee income			
	IPTW frequency			
DCA	84.5%			
Non DCA	68.9%			
	IPTW logistic regression			
	B	S.E.	t	Sig.
(Constant)	.797	.265	3.008	.003**
DCA dummy	.901	.565	1.596	.114.
N (unweighted)				
DCA	32			
Non DCA	68			
N (weighted)				
DCA	121.6			
Non DCA	94.1			
R^2 (Nagelkerke)	.052			

*Significance levels: ***=0.001; **=0.01; *=0.05; °=0.1; .=0.15*

4.2.5. Testing hypothesis 9: Greater increase in income (returns of investment) and less food insecurity over time among couples who adopted participatory decision making

Before we analyse the change over time in household economic wellbeing and food security in relation to participatory decision making, we look at the current (self-declared) household food insecurity and economic wellbeing. We measured subjective relative household economic wellbeing with an indicator based on respondents' opinion whether their household is (much) better off, the same or (much) worse off, in terms of income and consumption, than the average household in their community (Table 11). There are no remarkable discrepancies between DCA and non DCA women, nor men, except that more non DCA men than DCA men believe they are worse off in comparison to other households in their community.

The indicator for household food insecurity is based on respondents' indication that, in the 3 months prior to the interview, their household members ate fewer or smaller meals or were not able to eat the commonly preferred foods because there was not enough food or resources. The high proportions of people indicating their household is food insecure are due to the timing of the survey when food security is a recurrent seasonal challenge and to the high incidence of banana Xanthomonas wilt disease in plantain plantations in this area which reduced food availability (Table 11).

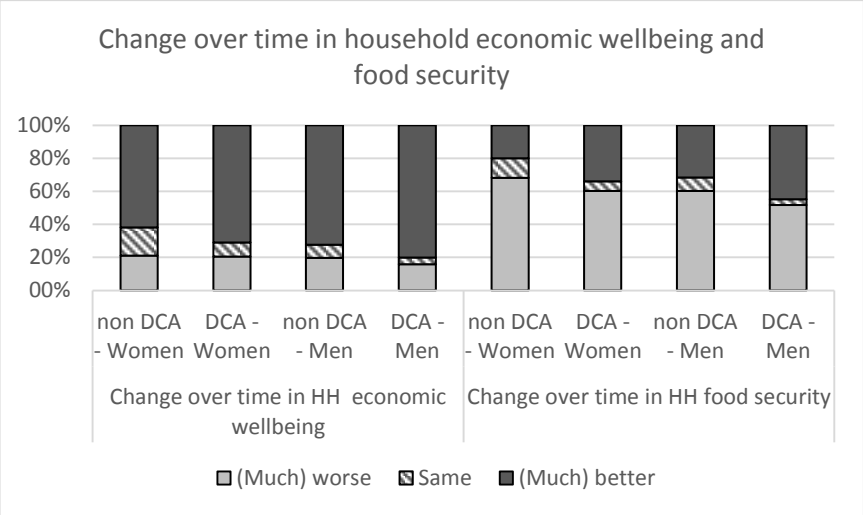
Table 11 IPTW percentages per level of subjective household wellbeing

	Women DCA	Women non DCA	Men DCA	Men non DCA
Subjective relative well-being				
(Much) worse	25.7%	19.1%	11.0%	24.1%
Same	43.8%	50.5%	45.1%	37.5%
(Much) better	30.5%	30.5%	43.8%	38.4%
Food insecure	59.7%	63.4%	53.0%	50.2%

Participatory intra-household decision making is expected to contribute to improving household wellbeing and food security through the combined effect of greater investment in the common household farm, fairer and more sustainable consumption from the household income, reinforced through repeated interactions. In Figure 7 we plotted the percentages of DCA

and non DCA women and men who believe the economic wellbeing of their household, respectively the food security situation, has worsened (much), remained stable or increased (much) as compared to four years ago.[14] Most respondents believe their household's economic wellbeing has improved over time. Men are somewhat more optimistic than women; and DCA men (resp. DCA women) somewhat more than non DCA men (resp. non DCA women). But the likelihood of an improvement in economic wellbeing, as reported by women, is the same for DCA and non DCA households (insignificant coefficient for the DCA dummy in Model A in Table 12). The same applies for improvement in wellbeing, as reported by men (Model B). Yet, in support of our hypothesis, the second most mentioned reason by DCA men and DCA women for improved economic wellbeing is the fact that they now jointly plan and manage the household farm.

Figure 6 Change over time in subjective household wellbeing and food security



Most respondents indicate that their household's food security situation has worsened over time. But more DCA men report an improvement the food security situation as compared to non DCA men; the same applies for women (Figure 6). The positive significant coefficient of the DCA dummy in model C shows that the likelihood of an improvement in household food security, as reported by women, is greater among DCA than among non DCA households (Table 12). This is not the case for the likelihood of improved food security, as reported by men (insignificant coefficient for the DCA dummy in model D)..

[14] We used the previous presidential elections as a reference date which is a commonly remembered event that took place four years prior to the survey.

Table 12 The likelihood of improvement of household wellbeing and food security over time as reported by women and men

Dependent Variable	Improved wellbeing (woman reported)				Improved wellbeing (man reported)				Improved foodsecurity (woman reported)				Improved foodsecurity (man reported)			
	IPTW frequency				IPTW frequency				IPTW frequency				IPTW frequency			
DCA	71.0%				80.2%				34.0%				44.8%			
Non DCA	61.9%				72.4%				20.0%				31.7%			
	IPTW logistic regression Model A				IPTW logistic regression Model B				IPTW logistic regression Model C				IPTW logistic regression Model D			
	B	S.E.	z	Sig.	B	S.E.	z	Sig.	B	S.E.	z	Sig.	B	S.E.	t	Sig.
(Constant)	.484	.246	1.971	.051°	.965	.265	3.634	.000***	-1.388	.292	-4.748	.000***	-.769	.255	-3.019	.003**
DCA dummy	.409	.457	.896	.372	.432	.496	.871	.386	.723	.465	1.555	.123.	.560	.430	1.302	.196
N (unweighted)																
DCA	36				36				36				36			
Non DCA	72				72				72				72			
N (weighted)																
DCA	136.7				136.7				136.7				136.7			
Non DCA	99.5				99.5				99.5				99.5			
R^2 (Nagelkerke)	.013				.012				.034				.024			

*Significance levels: ***=0.001; **=0.01; *=0.05; °=0.1; .=0.15*

Based women's opinion, we can say evidence support the hypothesis of a positive relation between food security and participatory decision making. In addition, change agents link their improved wellbeing to participatory decision making.

5. Discussion and conclusion

Part of the reasons why smallholder household farming systems are not always efficiently, sustainably and equitably managed can be found in the way intra-household decisions are made. In this article we examine the relation between a way of intra-household decision making that reduces information asymmetries and power imbalances between spouses and cooperative outcomes. We study smallholder coffee farming households in western Uganda.

We compare investment and consumption behaviour in an experimental setting of men and women in change agent couples, who adopted participatory household planning and decision making as encouraged through a gender program by the Hanns R. Neumann Stiftung (HRNS), with men and women in couples who did not adopt participatory decision making. We also relate participatory intra-household decision making with real outcomes of investment and consumption behaviour measured with individual survey data. We specifically look at adoption of sustainable intensification practices, intra-household reproductive and productive time allocation, equality of control over household farming income, economic wellbeing and food security.

Our *first hypothesis* that couples who adopted participatory decision making contribute more to investments in the household commons in the experiment than others is confirmed. Especially wives in change agent couples contribute significantly more than non-change agent wives. We did not find experimental evidence, however, for our *second hypothesis* that participatory decision making is associated with spouses contributing more equal amounts to the household commons.

There is a weak indication that husbands in change agent couples consume smaller shares, amounting to somewhat less than half, of the household income generated through investment in the commons in the experiment than husbands in non-change agent couples when the total household income generated is medium high. Otherwise there is no support for the *third hypothesis* that participatory decision making is related to fairer and more sustainable use of the household income. For women, fair consumption is more likely when their contribution was medium high but does not relate to being change agents. Couples are more likely to con-

sume in a fair way if the household income is medium high.

Looking at outcomes of intra-household investment behaviour in reality, our results confirm our *fifth hypothesis* of a higher likelihood of adopting sustainable intensification measures (by men) for the most important cash crop, i.e. coffee, in households whom adopted participatory decision making. Especially the adoption of coffee specific sustainable intensification practices and of nutrient enhancing practices is higher among change agents than among non-change agents. The picture looks different when it comes to intensification of food crop, in particular cassava, which is mostly managed by women or jointly with their husband. Few sustainable intensification practices are applied for cassava production and only the adoption of intercropping is positively related to participatory decision making, which is a widespread practice anyhow.

The evidence to support our *sixth hypothesis* that women's interests are more taken into account when couples have adopted participatory decision making is not tremendously strong. As indicated above, there is little evidence of more investments in (intensification of) food crop production. There are weak (but insignificant) indications of a higher likelihood of joint ownership of plots on which coffee is grown among change agent couples. But, women are significantly more likely to personally or jointly own plots on which food crops are grown in change agent couples than in non-change agent couples, possibly enhancing their control over and benefits from these crops.

We cannot say that participatory decision making makes a difference for the intra-household fairness of time allocated to productive activities as stated in *hypothesis seven*. Overall, there is fairly equal time spent on farm work in all households and most are of the opinion that farm work should be equally divided among spouses, regardless of having adopted participatory decision making or not. In support of hypothesis seven, indirectly, there is a relation between participatory decision making and men allocating more time to reproductive tasks. More change agent husbands agree men should help with reproductive tasks and that opinion is positively correlated with the time husbands spend on reproductive tasks.

If we can assume that agreed upon joint control over the largest share of the cash crop income, coffee in this case, from also effectively means that control over the use of that income is balanced between spouses, then our results support *hypothesis eight*: There is more balanced control over income in couples who adopted participatory decision making.

The likelihood that women report improved food security is significantly higher in households who adopted participatory decision making than in other households. Assuming that wives are better informed than husbands about the household's food security situation, this supports (part of) *hypothesis nine*. There are indications, albeit not significant, that the likelihood of advancing economic wellbeing is higher among change agent then among non-change agent couples. But change agents see their participatory way of decision making as an important reason for improving wellbeing. Taken as a whole, participatory decision making seems to contribute to farming systems that are better able to sustainably satisfy the cash and food needs of the households and, as such, to improve wellbeing and food security. The fact that more change agent households than other households manage to become more food secure - in a setting with serious food security challenges - may also indirectly indicate that women in these households had a stronger say in decisions about the household farm and income and ensured sufficient food that way.

Different elements in our analysis point to a higher likelihood of cooperative out-

comes when agricultural households, as collective action institutions, adopt favourable 'rules of the game', in this case participatory intra-household decision making about production and resource allocation. Participatory intra-household decision making about household farm production and consumption possibly contributes to reducing information asymmetries and (bargaining) power imbalances between spouses and, as such, inspires more cooperative outcomes, i.e. more sustainable, efficient and equitable household farming systems.

We identify three main ways forward to further explore the relationship between intra-household decision making and efficient, sustainable and equitable household farming. First, a random introduction of a program encouraging participatory decision making would allow attributing more confidently changes in household farm investment and consumption behaviour to changes in intra-household decision making. Secondly, it could be enlightening to study approaches that aim to change intra-household decision making by enhancing women's bargaining power through building women's human capital, income or asset base. Thirdly, a more cooperative outcome may also consist of a whole different household farming system, a changed combination of food crops, cash crops and livestock. An analysis from a farming system perspective would allow exploring this.

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Annex A: Assessment of the balance of Propensity Score Matching

Table 13 Sample sizes in propensity score matched and original samples

Sample Sizes

	Control	Treated
All	99	36
Matched	72	36
Unmatched	27	0
Discarded	0	0

Table 14 Assessment of balance before and after matching

	Detailed balance before matching				Detailed balance after matching			
	Means Treated	Means Control	SD Control	Std. Mean Diff.	Means Treated	Means Control	SD Control	Std. Mean Diff.
propensity	.284	.260	.057	.289	.284	.271	.062	.159
ID_11_HB	44.667	42.343	12.867	.187	44.667	42.931	13.578	.140
DIFF_age	-7.611	-6.798	6.015	-.121	-7.611	-7.014	5.961	-.089
DIFF_edu	-1.083	-.828	1.143	-.168	-1.083	-.986	1.181	-.064
HH_163_HB	3.694	3.141	1.974	.199	3.694	3.389	2.166	.110
propensityxpropensity	.087	.071	.032	.308	.087	.077	.035	.192
propensityxID_11_HB	13.338	11.392	5.341	.269	13.338	12.079	5.818	.174
propensityxDIFF_age	-2.345	-1.915	1.902	-.178	-2.345	-2.081	2.017	-.109
propensityxDIFF_edu	-.386	-.253	.346	-.256	-.386	-.308	.367	-.151
propensityxHH_163_HB	1.222	.899	.777	.233	1.222	1.016	.865	.148
ID_11_HBxID_11_HB	2144.500	1956.848	1212.115	.155	2144.500	2024.847	1285.692	.099
ID_11_HBxDIFF_age	-379.722	-319.778	342.913	-.137	-379.722	-340.458	352.705	-.090
ID_11_HBxDIFF_edu	-52.917	-35.434	47.831	-.240	-52.917	-42.417	48.899	-.144
ID_11_HBxHH_163_HB	180.778	145.242	122.796	.192	180.778	160.389	135.845	.110
DIFF_agexDIFF_age	101.778	82.030	119.789	.128	101.778	84.236	118.444	.114
DIFF_agexDIFF_edu	6.972	4.465	10.111	.175	6.972	6.208	10.441	.053
DIFF_agexHH_163_HB	-29.972	-23.242	29.455	-.155	-29.972	-26.875	32.788	-.071
DIFF_eduxDIFF_edu	3.417	1.980	3.149	.304	3.417	2.347	3.561	.226
DIFF_eduxHH_163_HB	-4.556	-2.747	4.207	-.266	-4.556	-3.389	4.518	-.171
HH_163_HBxHH_163_HB	21.139	13.727	21.067	.197	21.139	16.111	23.906	.133

(ID_11_HB= age husband; DIFF_age= (age wife – age husband); DIFF_edu= (education level wife – education level husband); HH_163_HB= acreage farm reported by husband)

Table 15 Tests of imbalance

Tests of imbalance	Before matching	After matching
Relative multivariate imbalance measure L1	.843	.833
Unbalanced covariates (|d| > .25)	No covariate exhibits a large imbalance (|d| > .25).	

Figure 7 Distribution of propensity scores and line plot of standardized differences before and after matching*

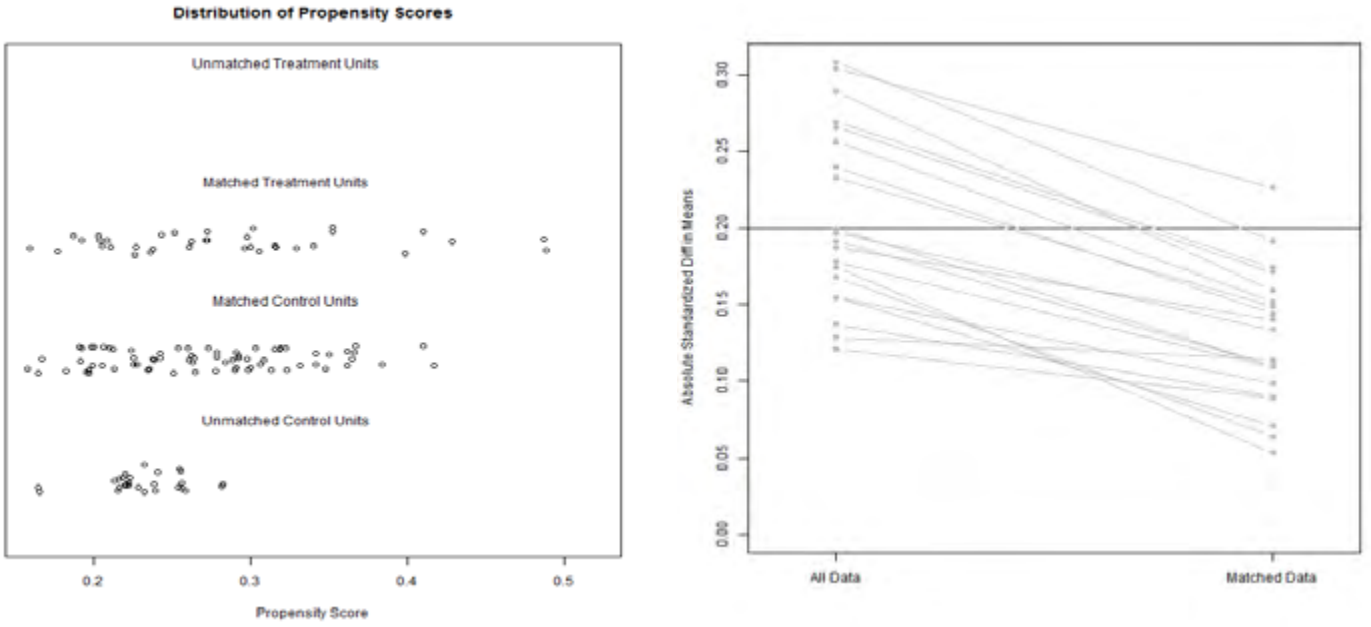
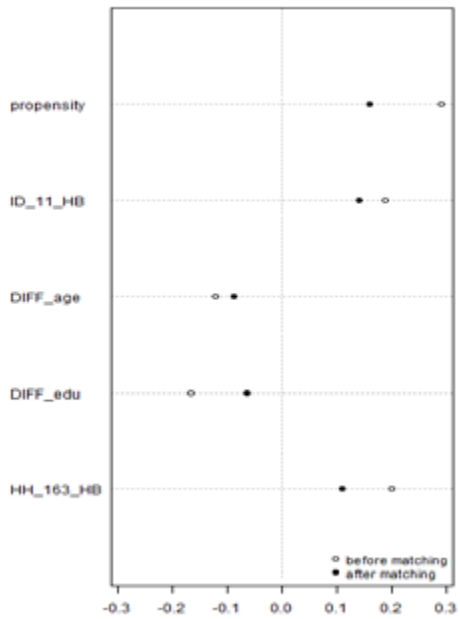


Figure 8 Standardized mean differences (Cohen's* d*) before and after matching*



(* Thoemmes, F. (2011). An SPSS R Menu for Propensity Score Matching.)

Annex B: Descriptive statistics of the matched operational sample

Table 16 Descriptive statistics of the matched operational sample

	DCA		Non DCA	
	IPTW average	S.E.	IPTW average	S.E.
Age wife	35.7	1.8	36.3	1.4
Age husband	42.7	2.0	43.6	1.6
Acreage farm (husband reported)	0.5	0.1	0.5	0.1
Household size (wife reported)	8.0	0.6	7.9	0.3
Value off-farm income wife	52861.9	19925.7	74680.6	19742.3
Value off-farm income husband	281041.0	63524.9	183760.7	34983.2

Table 17 Descriptive statistics of the matched operational sample

	DCA women	DCA men	Non DCA women	Non DCA men
Level of education				
No formal education	24.0%	9.3%	39.1%	9.4%
Primary up to primary 4 (P4) (incl. adult learning)	33.6%	22.7%	27.5%	15.3%
Primary up to primary 7 (P7)	20.3%	27.6%	26.9%	45.5%
Secondary up to senior 4 (O level)	22.0%	29.9%	5.0%	23.6%
Tertiary		10.6%	1.6%	6.2%
Most important food crop (Season B)				
Cassava	82.3%	89.2%	88.8%	88.5%
Banana	15.9%	10.8%	8.5%	10.3%
Maize	1.8%		1.4%	
Irish potato				1.2%
N/A			1.2%	
Most important cash crop (Season B)				
Coffee Arabica	91.6%	94.1%	97.4%	97.2%
Cassava	3.2%	3.2%	1.3%	
Beans	2.1%		1.3%	
Banana		2.7%		1.4%
Maize				1.4%
N/A	3.1%			

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