Smallholder Impact Evaluation of Maize Value Chain Development in Tanzania

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1 Summary and Key Findings

This document describes the design of the impact evaluation of the Farmer to Market Alliance (FtMA) and WINnERS intervention, and the findings of the baseline survey that was carried out as part of this evaluation. The aim of the impact evaluation is to measure and understand the impact of the FtMA and WINnERS intervention on maize producing farmers in Tanzania. The baseline data was collected to describe the household and farming characteristics of the households that are being targeted in the intervention. As such, the baseline document is purely descriptive, and serves to document the situation of maize farmers in Tanzania before the FtMA and WINnERS intervention is rolled out.

A Randomized Control Trial (RCT) was designed to measure the impact of FtMA and WINnERS on different household and farming outcomes in Tanzania. The RCT randomly assigned 108 Farm Organizations located in the center, north and south of Tanzania to different treatment groups to identify the impacts of FtMA and WINnERS. Data was collected on a total of 1,933 households who were members of the different FO groups to understand the household characteristics; maize farming practices; agricultural production systems; financial, time and risk constraints; and general livelihood strategies of households that are targeted by the FtMA and WINnERS intervention.

The main findings from the baseline data regarding maize production are the following:

1. The large majority of the interviewed households are self-employed and active in agriculture. 25% of the households have anyone in the family that operated a non-farm enterprise during the last 12 months. Very few households have other non-labor income sources (e.g. land rental or remittances).
2. 27% of the farmers in the baseline sample falls below the 1.9 USD /day poverty line. Most of the households have an adequate food security status and an acceptable food consumption.
3. Decision making in the household about who performs different tasks in the household seems to be fairly balanced between males and females in the household. The involvement of children is rather small, except for activities that are related to agriculture. Males and females also seem to have similar access to resources and the benefits generated from these resources.
4. Households cultivate on average more 2.1 hectares of land, and the farm size in the north and center of Tanzania are larger than in the south. Farm size also tends to be positively related with asset wealth.
5. Most farmers cultivate only one or two plots, which are cultivated in the long rainy season, mostly owned by the household and where rain is the source of water.
6. Maize is the most popular crop, grown on 72% of the plots. Maize plots are on average 1.8 ha and only 30% of the plots is intercropped with other crops.

7. Farmers show relatively high (compared to LSMS data for the whole of Tanzania[1]) uptake of modern inputs. More than half of the famers used hybrid maize seeds or any type of inorganic fertilizer (containing N, P or NPK) during the last maize production year. Uptake of agro-chemicals is lower (30% of the households), but still relatively high. Few households however simultaneously apply modern inputs on the same plot.
8. Households on average spend 96 USD per hectare on modern inputs in maize. Most farmers buy inputs from local agro dealers (75%) and used cash out of the pocket to finance input purchase.
9. Family labor is the main source of work force, accounting for 88% of the labor used in maize production. Females on average supply a bit more family labor than males. The use of hired labor is especially for weeding. 48% of the households indicate to have used mechanized power in maize production, especially for tilling the soil. The usage (and ownership) of machinery is larger when farm size or asset wealth is larger or when village wage rates are higher.
10. Farmers produced on average 2.2 ton of maize per hectare of land, which is mainly used for consumption (43%), sold at the market (39%) and storage (15%).
11. For those that sold maize, the majority does this because they need cash (61%) or need to pay fees (17%). Maize is usually sold in the village (83%) and mostly to middlemen (61%). Farmers who sold maize receive on average 276 USD per hectare, which corresponds with a maize price of 4167 TSH per kg. Those that did not sell maize do this because they want to keep the maize output for home consumption or because there was no surplus to sell.
12. The net income (gross minus expenditure on modern inputs and hired labor) for maize selling households is 137 USD per hectare of maize produced. Male headed households earn slightly more from maize income, as do farmers that have a larger farm.
13. 90% of the farmers dried the maize before selling. The majority of the farmers (95%) shelled the maize and used the sun to dry the maize at the field. 74% of the farmers had maize stored at the time of the interview at the household (85%) or with family (9%). Maize is primarily stored as food for household (84%) and not so much for selling at higher price later in the season (12%). PICS bags are the most dominant storage facility (61%) followed by open drums (24%).
14. Farmers have used modern inputs for several years. Farmers receive information about modern inputs and farming techniques from both extension agents and social learning in their peer network. However, half of the farmers are not explicitly trained on input application. This results in limited agricultural knowledge on how to apply the inputs correctly.
15. 15% of the farmers took a loan, with an average (total) value of 611 USD. Loans are mostly taken for agricultural inputs and investments, and obtained from self-help groups or micro finance.

[1] See the Policy Research Working Paper prepared by Sheahan and Barrett (2014): "Understanding the Agricultural Input Landscape in Sub-Saharan Africa Recent Plot, Household, and Community-Level Evidence" http://documents.worldbank.org/curated/en/165341468002108906/pdf/WPS7014.pdf

PART I:

DESCRIPTION OF THE
FtMA – WINNERS INTERVENTION
AND
IMPACT EVALUATION

2 Background

Over the past decade, Tanzania has experienced a period of steady growth, which reached 7 percent on average during the last three years. Yet, the decrease in the poverty headcount ratio has been limited (from 33.4 to 28.2 percent between 2007 and 2011/12 respectively), except in Dar es Salaam (where the poverty headcount ratio declined from 14.1 to 4 percent). National household panel surveys even report an increase in the rural poverty rate (from 17.2 percent in 2008/9 to 26.4 percent in 2012/13).[2] More than 35% of the children under the age of five are also still stunted (2015 estimates).

An important step towards more widely-shared prosperity lies in increasing staple crop productivity and the broader transformation of the agricultural sectors. Virtually all rural households in Tanzania participate in agriculture, where they earn on average 70 percent of their income.[3] However, cereal yields and agricultural labor productivity remain low (1464 kg/ha and 563 US$/worker respectively)[4]. Low staple crop productivity, little value addition and the continuing dominance of agricultural livelihood systems combine to keep poverty in Tanzania at stubbornly high levels.

With the land frontier closing, agriculture's lackluster performance is importantly linked to its limited use of modern farming techniques. A host of reasons have been invoked to explain this, including poor agronomic practices, financial markets constraints (savings, credit and insurance), and remoteness. Together these constraints have kept agricultural production as a risky, low-return activity.

Addressing a singular constraint has rarely proven to yield the necessary productivity boost, as has been demonstrated again by the limited effectiveness of the "smart input subsidy programs".5 At the same time, Ethiopia's and Rwanda's recent success in doubling smallholder staple crop productivity suggests that integrated approaches that simultaneously address knowledge, credit and market access constraints can be effective.

The essence of the more integrated models is to directly involve all actors in the value chain (VC) and link smallholder producers more directly to the markets through contract and marketing

2 Belghith, Lopera and Ndip, 2015, Analysis of the Mismatch between Tanzania Household Budget Survey and National Panel Survey Data in Poverty and Inequality Levels and Trends, World Bank, mimeographed.

3 Income from crops (which makes up the bulk of income), livestock and agricultural wage labor (only a small share) combined. Davis, Di Giuseppe and Zezza, 2015, Income Diversification Patterns in Rural Sub-Saharan Africa, World Bank Policy Research Working Paper 7108, World Bank: Washington D.C.

4 Averaged over 2012-2014. World Bank Development Indicators 2016.

5 Following Malawi's lead in the mid-2000s and in response to the world food crisis there has been a revival of input subsidy programs across Africa. Yet, it is increasingly becoming clear that they have not yielded the hoped for results and that they are fiscally unsustainable. For a rationale of the programs and review of the recent experience see, respectively, Morris, M., et al., 2007, Fertilizer Use in African Agriculture: Lessons Learned and Good Practice Guidelines, Washington D.C.: World Bank. Jayne, T., and S., Rashid, 2013, Input Subsidy Programs in sub-Saharan Africa: A Synthesis of Recent Evidence, Agricultural Economics 44-6: 547-562, respectively.

arrangements with input companies, processing factories or marketing agents. Based on these arrangements higher volumes of more consistent quality can be procured by the stakeholders in the chain in return for access to credit, agronomic knowledge and a reduction of production and market risks for the producers.

Broadly, three different models can be distinguished, depending on who “leads”. Under the first model (‘pulling from above’), it is a lead firm in the chain (e.g. input provider, a processor, wholesaler or retailer/supermarket) which takes the initiative to coordinate and contract farmers or farmer organizations (FO) to produce certain amounts of produce of a pre-determined quality in return for credit, inputs, agronomic knowledge, market access, and/or risk reduction. Under the second model (‘pushing from below’), the initiative to overcome coordination costs and facilitate cheaper access to inputs and markets for its members, lies mainly with the FO themselves. Under the third model (‘mediating from the middle’), an external agent acts as broker by creating a platform to bring producers and other actors in the chain together to help remove mutually perceived obstacles to expand market access (including through the provision of public goods and services) and help distribute the gains from value addition.[6]

Irrespective of the model, contract enforcement and breakdowns are major challenges. Farmers fear that firms won’t honor their contracts at the time of purchase (or when providing the inputs); firms fear that farmers won’t sell their goods to them, or sell them goods of the wrong quality, given other better opportunities at the time of sales. Contract enforcement is especially challenging when it comes to staples. These are typically more uniform, delivered in bulk, with less potential for differentiation through value addition. This reduces the opportunity for firms to tie in producers through premiums, and increases the opportunity for farmers to side-sell, if temporarily better sales conditions present themselves.

Against this background, the World Food Programme (WFP) has initiated the Farm to Market Alliance– referred to as FtMA hereafter—to promote the sustainable growth of smallholder farms in a number of African countries. The FtMA is demand-led consortium of public and private value chain partners, facilitating smallholder farmer participation across the entire value chain in order to raise their marketable surplus production and subsequently, livelihoods. The Alliance brings together multiple stakeholders – including WFP, the International Finance Corporation (IFC), a Green Revolution in Africa (AGRA), Grow Africa, Bayer, Syngenta, Yara, and Rabobank – with the purpose of creating systemic, demand-led change along agriculture value chains that promotes inclusion of smallholder farmers.

More particularly, in Tanzania, the Alliance focuses on maize production and aims to connect about 75,000 smallholders to supply chains for commercial maize markets by linking FO to domestic buyers (through guaranteed market access at a minimum price), financial institutions (for credit),

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[6] Swinnen and Kuijpers, 2017, Inclusive Value Chains to Accelerate Poverty Reduction in Africa, LICOS Centre for Institutions and Economics Performance, KULeuven, mimeographed.

input providers (Yara, Syngenta, and local partners) and extension service providers (facilitated through NGO's). In 2016, an innovative index based weather insurance component was added to this FtMA intervention (developed by Imperial College London (ICL)), which helps reduce credit default risk by absolving farmers from credit payback in case of weather failure.

This maize VC development initiative carried by private sector stakeholders and IFC, coordinated by WFP and AGRA and supported by the WINnERS consortium of academic institutions and the Jobs Group of the World Bank Group (WBG) provides a unique opportunity to learn about the potential of one of the integrated approaches to boost agricultural productivity (the "mediating from the middle model"). With maize the key staple in southern and eastern Africa, the lessons learned will have wide ramifications for poverty reduction and shared prosperity. They will help the WBG and its partners reach Sustainable Development Goals (SDG) 1 and 2. Close involvement of the WBG will facilitate incorporating the lessons in future agricultural projects and government initiatives. Close collaboration with WINnERS ensures analytical rigor of the findings.

This document presents the baseline survey data collected to evaluate the impact of this initiative. The baseline survey is financed by the Let's Work Tanzania Programme of the World Bank and Imperial College London. The research team that will design, oversee and analyze the impact evaluation (IE) is a partnership among the Jobs Group of the World Bank (represented by Luc Christiaensen, Lead Agricultural Economist, Jobs group), Imperial College London (represented by Erik Chavez, Principal Researcher and Director of the WINnERS project), the Global Agriculture and Food Security Program (GAFSP) and IFC (represented by Niraj Shah, Acting Head of GAFSP Private Sector Window, and Yanni Chen, Senior Results Measurement Specialist of IFC, and M&E officer for GAFSP).

3 Description of FtMA intervention

3.1 Market to Farm Alliance

The Farm to Market Alliance (FtMA) uses an integrated VC approach to procure staple crops directly from smallholders across several countries in Sub Saharan Africa. By aggregating demand from a consortium of buyers over longer periods than typical spot contracts (three to five seasons), the Alliance seeks to develop the whole value chain, unlocking services downstream (e.g. inputs, extension, loans, insurance) through a system of assured buying contracts. The Alliance is currently active in four countries: Tanzania, Rwanda, Zambia and Kenya. In Tanzania, the approach focuses on improving the livelihoods of maize farmers belonging to local FO.

The Alliance makes it possible for farmers to sell high-quality crops by linking farmers to maize buyers and facilitating access to fair harvest contracts before planting begins, obtaining agricultural inputs and credit to increase yields, and offering other forms of support from consortium members or other providers.

Specifically, the FtMA gives farmers access to a structured and assured market through contracting. Contracts are arranged at the FO level, which is legally responsible. The FO engages its members (primarily) to participate. Before planting, eligible FOs sign a formal contract with a domestic (or international) buyer, who joins the Tanzania FtMA platform. The Alliance works through a consortium of responsible buyers and other market players, interested in engaging with small farmers to ensure a sustainable and resilient supply chain. Currently buyers include several players from the domestic private sector (millers, breweries, wholesalers). The buyer commits to buy a pre-specified volume of produce (maize) and to pay the market price per Kg, with a preset guaranteed floor price, calculated based on the cost of production plus a small profit margin. The actual market price paid to farmers is determined at the time of sales (if the general market price post-harvest exceeds the floor price). The contracts provide farmers with a guaranteed market for a set amount of their produce as well as a minimum price guarantee.

Second, the FtMA also offers the members of the contracting FO access to a package of quality agricultural inputs. These include improved seeds, inorganic fertilizers, herbicides, and pesticides, all specifically selected to fit with the local agro-ecological circumstances. The package is delivered along with a ‘demo’ day of practical training on the appropriate use of these products. The components of the package are supplied by different international companies –with local branches– that are part of the FtMA. The package represents a great shift from traditional input use that consists mainly of local and uncertified—often fake–seeds and fertilizers, with herbicides and pesticides mostly unavailable.

Farmers who decide to adopt the input package can pay either directly, or pay 20% of the total value upfront and take a loan at the local (FtMA partnering) bank for the remaining part (with 80% of loan default risk covered by IFC and other development partners). Loans are made to the FO by group guarantee and the application process works as follows. FOs that have been approved by

Private Agricultural Sector Support (PASS, see below) apply for loans from the banks based on the size of their intended input order. This application involves a credit check from the bank and a business plan prepared by PASS, and a 20% collateral on the loan is required from FOs. This must be collected from their members and paid to the bank. Distribution of loan to input supplier is direct from the bank not via the farmer. Repayment of the loan (using balloon repayment) is made through the buyer's direct payment to bank after the sale of the commodity at the end of the season.

Third, farmers receive agricultural counseling via locally-based field officers and are invited to a series of classroom trainings on Good Agricultural Practice (GAP) and post-harvest management. The field officers can propose customized solutions to the farmers' problems and help farmers to adapt the new products and technologies to their specific conditions.

3.2 The WINnERS insurance product

The Weather Index based Risk Services (WINnERS) project offers risk management services to build resilient supply chains from the smallholder to the global retailer. Under WINnERS, academics and climate scientists (led by ICL) partner with insurance industry experts and global food buyers to build products that can protect both food buyers and producers from weather and climate driven risk. At the farm level, the likelihood of an extreme weather event and its severity can be predicted across areas as small as 5 by 5 kilometers. As the rainfall thresholds for triggering a form of relief will be based on microclimates, the likelihood of basis risk – a mismatch between contractual expectations and performance – is significantly reduced. The WINnERS insurance distinguishes from other agricultural insurance contracts because (i) farmers are not the insurance policy holders, and (ii) risk is shared geographically between FOs across the country and between various actors of a particular supply chain. This is achieved through one single national policy held by PASS on behalf of the FOs.

In Tanzania, WINnERS developed a weather index based insurance product[7] that covers crop losses farmers might occur do to climatic events. WINnERS modeled for each location (based on 5 by 5 kilometer pixels) in Tanzania the maize yields farmers can expect to achieve based on historical climate data. When the yields farmers realize in the fields are lower than the modelled yields, the insurance will be triggered and farmers will receive a crop loss payout. This insurance component was added to the initial FtMA input loan package in the maize production season starting in October-November 2016. Hence, next to access to assured market, credit access, modern inputs and extension and post-harvest management training; farmers now have the opportunity to insure themselves against crop losses due to climatic events.

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[7] Under an EU funded project, the WINnERS team modelled weather and climate risk exposure through intensive data analysis and state-of-the-art technology and it evaluated the optimal level of insurance payout to ensure the sustainability of the value chain via the retention of all the actors. The optimal level of payout at the farmer, buyer, and bank levels was derived by estimating the propensity to side-sell at different payout levels, looking at different weather scenarios, and considering the necessary return thresholds required by banks and buyers to remain in the value chain.

The insurance will be offered to the local banks and input suppliers to transfer some of their credit default risk to the global insurance market. When the banks or input suppliers take up the insurance, the insurance will be passed on to the farmers through the provision of "insured credit". This means that the weather insurance product is coupled with the input loans taken by FOs from the local banks and input credit taken by FO from input companies. Farmers pay a higher interest rate in return, as risk premium. This loan principal payed by the farmer includes an insurance premium of 2.95% (+taxes) and interest rate for the credit (around 17 %) and covers the cost of insuring 40% of the input costs.[8] The remaining 60% is covered by risk guarantees provided by PASS to the banks and WFP to the input providers. Farmers will be exempted from having to pay back their credit loan taken with either a local bank or the input supplier (and get their down payment returned), when the weather based insurance is triggered. [9]

PASS is policyholder and aggregates all the risk of FO accessing bank loans or input company credit. In the event of crop loss driven by weather as determined by the WINnERS models, payouts will be made by the re-insurer Munich-Re to the local insurance front Jubilee. Jubilee will transfer these payouts, and details of which FO they correspond to PASS. PASS will be responsible for transferring to the bank accounts of the FOs. Farmers will be exempted from having to pay back their credit loan taken with either a local bank or the input supplier (and get their down payment returned).

3.3 Implementation of FtMA in Tanzania

The first round of the Tanzanian FtMA was initiated in the production year 2015-2016 aiming to achieve a target of 25,000 farmers. However, the actual amount of farmers covered by the FtMA was 21,000 farmers located in 29 FOs. It was implemented in three zones and nine regions across the three main maize areas of Tanzania:

16. Kilimanjaro, Manyara, Arusha in North Tanzania (total of 6,000 farmers)
17. Morogoro, Singida, Dodoma in Central Tanzania (total of 8,000 farmers)
18. Njombe, Ruvuma, and Iringa in South Tanzania (total of 7,000 farmers)

Although not a statistically representative sample, these nine regions represent Tanzania's key maize producing areas. The services offered to the farmers included input credit, Forward Delivery Contracts (FDC), GAP training, post-harvest training, aggregation centers, drying and post-harvest equipment. The total amount aggregated by farmers in Tanzania throughout the harvest season was

[8] This means in the event of a severe weather event the farmer will receive 40% of the cost of inputs in the form of a payout to their loan account.

[9] PASS is policyholder and aggregates all the risk of FOs accessing bank loans or input company credit. In the event of crop loss driven by weather as determined by the WINnERS models, payouts will be made by the re-insurer Munich-Re to the local insurance front Jubilee. Jubilee will transfer these payouts, and details of which FO they correspond to PASS. PASS will be responsible for transferring to the bank accounts of the FOs.

19,707 Metric Tons (MT). All of this aggregated amount was sold, and the off-takers that bought the maize were the FtMA buyers (12%), 25% to National Food Reserve Agency (NFRA) (25%), and other buyers (63%). The total value of input loans that were dispersed stands at TSH 1,791 million (USD 801,025 / GBP 606,837), and the corresponding loan repayment rate is now approximately 96%.

In the production season 2016-2017, WFP expanded the scope of FtMA to reach a total target of 50,000 farmers in Tanzania, including (i) the 21,000 farmers who already received the FtMA intervention in the previous year; and (ii) 29,000 new farmers. The latter group of farmers came from new FOs that had not received the FtMA intervention in 2015, but are assessed to be eligible to receive the intervention. The FtMA intervention provided to farmers in 2016 included the full set of agricultural services: input credit, tailor-made input packages, FDC, GAP training, post-harvest training, aggregation centers, drying and post-harvest equipment. While the market access facilitation is still on going, the FtMA in Tanzania was able to facilitate 47 FCDs between 53 FOs and 6 buyers from the FtMA. The WINnERS insurance product was launched in 43 FOs of the south of Tanzania.

The IE was designed in line with the roll out of the 2016 FtMA intervention in which the WINnERS insurance component was added as a new element. From the group of newly included FOs, FOs were assigned to different treatment groups. Two treatment groups were selected to be interviewed to analyze the effects of the FtMA intervention and the additional effect of the insurance. To demonstrate the effect of the FtMA intervention, a 'control' group of farmers needed to be selected as well, which allow a statistical impact assessment of the treatments. More information of the design of the survey is provided in section 4.[10]

[10] In practice, 107 FOs were surveyed, located in southern, central and northern provinces. However, the full PPP package was eventually only offered in the South this year, with FOs in the central and Northern provinces receiving only one or two components of the package (not the loans or insurance).

4 Design of the experiment

4.1 Rationale for the design of the experiment

The Impact Evaluation (IE) team adopts a randomized control trial (RCT) experiment to assess how the FtMA intervention and the weather-based index insurance affect the production, labor and welfare outcomes of farmers in the villages where FtMA was rolled out. To evaluate the impact of the intervention, we want to compare groups that received the intervention (i.e. the treatment group) (i) before and after they received intervention, and (ii) with groups that did not receive the intervention (i.e. the control group). A complication that arises is that the treatment group is not comparable with the control group, what is called the ‘selection bias’.

To avoid self-selection bias in the adoption of the intervention (both by the FOs as well as the farmers themselves), we will employ an RCT design. The RCT randomly assigns subjects to (a) treatment group(s) and to a control group. Doing so avoids the selection bias, as any difference between the different groups can be purely attributed to chance.

The RCT is clustered at the FO level, rather than randomization at the individual level. It thus captures the “intention to treat” effect, as opposed to the “effect on the treated”. This reduces the expected observed effect and thus increases the sample size needed to identify the effect (not everyone in the FO will participate in the program). Doing so is unavoidable; as program participation cannot be randomized at the individual level within the villages, (it would breach social harmony). One group of eligible FOs will be randomly assigned to receive the intervention and another group will serve as control.

4.2 Power of the RCT

The statistical power of the RCT depends on some key parameters of the intervention of experimental design like the expected outcome, number of FOs in the sample, number of interviews per FO, etc. The statistical power can be calculated upfront by making assumptions about those key parameters (using statistical software). The number of FOs in the sample is one of the most important determinants of the statistical power of the RCT. Hence, we if we set an acceptable statistical power for the RCT upfront (usually 80%), we can reverse the calculations to identify upfront the amount of FOs that is needed to include in the RCT to achieve this power. Preliminary power calculations performed using the Optimal Design software are shown below in Appendix 13.1. This calculation was done before designing the RCT to calculate the optimal number of FOs and interviews per FOs. We took a conservative approach by assuming that we could successfully include 110 FOs in the RCT sample and interview about 18 farmer per FO. This would result in a total of 2,000 observations in 110 FOs. The power calculations suggest that a sample of at least 110 FOs should be well-powered (80% power) to detect the expected effect size.

4.3 Selection of FOs to participate in the RCT

The most important criteria for the selection of FO to be part of the RCT universe is the comparability between FOs. Comparability means that the FOs that selected to be treated or not are comparable in terms of observed (yields, location, market access) and unobserved (managerial skills of FO members) in absence of the treatment. The requirement for FOs to participate in the FtMA is being able to prepare a loan application that will be assessed by the Private Agricultural Sector Support (PASS). Therefore, the RCT universe was based on the 'PASS list' of FOs that was constructed by WFP and given to PASS for assessment of loan eligibility. In this way, we made sure we were comparing apples to apples, i.e. FOs that are assessed to be eligible for a loan.

The IE randomly sampled FOs from the 2016 shortlist of FOs that were assessed to be eligible for participation in the second round of the FtMA project. The details on how the PASS selects FOs is presented in Appendix 13.2. To achieve the new 29,000 farmers of the 2016-17 campaign, PASS evaluated the eligibility of 150 FOs. From these FOs, a shortlist of 133 FOs was deemed to be eligible to receive the FtMA intervention (76 FOs are located in the south wile 57 FOs are located in the center and north of Tanzania). This PASS shortlist of eligible FOs was used by the IE team to perform sampling for the baseline survey. It was important that random assignment of FOs in the three different groups was done before the shortlist of FOs was sent to the banks, as to avoid potential contamination. Based on the above power calculations, an equal assignment rule was applied to each of the treatment arms: the control and both treatment groups received one third of the observations.

To improve the precision of the estimated effects and to take into account the heterogeneity across FOs, the randomization was stratified (or blocked) before randomly assigning treatment groups to FOs.[11] Four variables were used to stratify the eligible FOs on the shortlist into groups with similar characteristics. First, because stratification was done separately for south and center & north, we implicitly stratified on zone. Second, market access of each FO was calculated as the distance following the road network in Tanzania towards the closest big city. Third, to capture climatic conditions, FOs were grouped according to the long-term mean average rainfall. Fourth, a measure of net primary production was used as an indicator of agricultural potential. A total of 8 strata was thus constructed in each region by categorizing each FO to be above or below the average value of the stratification variables. Within each strata (or block) of FOs, we randomly assign the FOs to the different treatment groups

However, during the process of loan application, several eligible FOs in the south of Tanzania dropped out from the survey sample because of miscommunication by service providers and the

[11] Stratification based on baseline characteristics is considered one of the most appropriate techniques to increase the balancedness of the sample in RCTS (see for example Bruhn, M., & McKenzie, D. (2009). In pursuit of balance: Randomization in practice in development field experiments. *American economic journal: applied economics*, *1*(4), 200-232.)

fact that several smaller FOs were clustered in a larger FO (e.g. the apex structure). The final list of FOs that were covered in the baseline survey was 108.

4.4 Treatment groups

To be able to disentangle the various research questions (see section 4.6) and assess the differential impact of the FtMA package (assured market, minimum price, input and credit access, agronomic advice) and the impact of insurance (WINnERS project), the research team proposes to adopt two treatment arms and randomly allocate the FOs into three groups:

1. The control group: farmers who did not receive the FtMA intervention, nor insurance
2. Treatment 1 (T1): farmers who received the FtMA intervention without insurance
3. Treatment 2 (T2): farmers who received both the FtMA intervention and the insurance

Table 4-1 summarizes the services offered by FtMA to the different treatment groups

Table 4-1: Service offered by FtMA

Service	Control	T1	T2
Assured market and minimum price	**No**	Yes	Yes
Agricultural input package	**No**	Yes	Yes
Extension service	**No**	Yes	Yes
Loan	**No**	Yes	Yes
WINnERS insurance	**No**	**No**	Yes

The randomization of FOs in three treatment groups allows us to capture three effects:

1. Effect of the FtMA intervention on farmers' outcomes: Comparing the control group with treatment 1 group allows us to measure the effect of the FtMA intervention on farmers' welfare.
2. Effect of the FtMA intervention coupled with bundled insurance: Comparing the control group with treatment 2 group allows measuring the effect of the FtMA intervention combined with insurance on farmers' welfare.
3. Incremental effect of crop-loss insurance in the FtMA intervention: Comparing treatment 1 with treatment 2 allows us to measure the additional effect of insurance over the FtMA effect as it assesses whether bundling credit with insurance can increase input/credit uptake.

4.5 Intended versus realized outcome of the RCT

Based on the power calculation and the availability of 133 FOs to participate in the RCT, Table 4-2 summarizes the randomization outcomes over different regions and the different treatment groups. The randomization of FOs is done ex-ante and the outcome of the randomization depends on how it is implemented in the field. However, during the fieldwork (preparation) in the south, there were concerns that several Southern FOs did not receive the treatment they were assigned to, and in most cases we were forced to drop the FOs where there were concerns that the assigned treatment might not coincide with the actual treatment status.

The realized implementation of the randomization in the field is described in Table 4-2 per treatment group and region. The total of FOs for which the assigned treatment was correctly implemented in the field is 108. Moreover, the loss of FOs has mainly occurred in the control and T1 group, implying that an imbalance between treatment groups has grown. Appendix 13.3 shows the geographical location of FOs in the realized RCT.

Table 4-2: Targeted and realized outcome of the RCT

Region	Control	T1	T2	Total
	Targeted sample of RCT			
South	25	26	25	76
Center	3	6	6	15
North	16	13	13	42
Total	44	45	44	133
	Realized outcome of RCT			
South	11	19	21	51
Center	3	6	6	15
North	16	12	14	42
Total	30	37	41	108

4.6 Research questions

The detailed research questions are listed in Appendix 13.4

5 Data collection

The RCT aims to capture both short and long-term impacts of the FtMA and WINnERS intervention. To measure any effects, it is crucial to collect baseline data before the interventions were rolled out effectively in the field. Data from the baseline survey has been collected before maize was planted for the 2016-2017 growing season, i.e. during September - December 2016, the year before the FtMA was rolled out. Subsequently, two follow-up surveys are planned to measure short-term impacts (the midline – after 3 years) and longer terms impacts (the end line – after 5 years). This longer-term perspective is essential because it takes time for interventions to change farmers' investment behavior, and hence for us to measure it. More specifically, these three survey rounds have the following goals:

1. Baseline: the baseline survey collected background information on the interviewed farmers and the FOs before the next production season, and hence before the FtMA intervention is rolled out. It allows to compare the characteristics of the treatment groups with the control group. Moreover, it allows to look at the characteristics and factors of the farmers belonging to each treatment group. This has already informed the FtMA process.
2. Mid-line: the interviewed farmers will be revisited after a couple of years of FtMA project participation. The exact timing will be determined in function of implementation progress of the different FtMA packages (guaranteed market access, training, loan provision, input delivery, training, insurance) across the different regions (north, center and south). We can then analyze the characteristics that determine the uptake of the input package, the uptake of loans and the rate of default. Second, we can analyze the short – term effects of the FtMA intervention of farmers' welfare outcome.
3. End-line: Farmers will be interviewed five years after they were introduced to the FtMA project. This allows to understand longer-term uptake rates as well as welfare impacts.

The data for the impact evaluation thus will come from a series of household surveys. A competitive bid was sent out to several survey companies to implement the baseline survey. The survey company is tasked with for translating and digitalizing the survey questionnaires, selecting and training enumerators and field supervisors, conducting field interviews, and cleaning and processing the raw field data. The survey team selected The Economic and Social Research Foundation (ESRF) to be responsible for all of these tasks, after they received the questionnaire and sampling design from the I&E team.

The baseline survey was conducted in two phases. In a first phase, data was collected right after farmers finished the harvesting of the maize from production season 2015 – 2016. This allows to capture the maize input and output decisions of farmers the year before the intervention was rolled out, and avoids that farmers would confuse this year's input use with the previous one. However, this timing is not the ideal time for collecting food security indicators, as the time after the harvest is the time when most of the crop harvest (or sales income) is available to the household. Therefore, an additional food security baseline survey (the second phase) was designed to capture food security and consumption at the most pressing period for consumption, i.e., right before the harvest of the next season. This food security survey was fielded in 2018 in the southern and northern FOs.

5.1 Sampling of households

Data was collected from farmers that were randomly selected within each of the above selected FOs. To anticipate less than perfect uptake of new interventions by farmers, we oversampled the group of treatment farmers in FtMA. The baseline survey was first fielded in the south of Tanzania and in a second step in the center and north of Tanzania. The number of farmers that were interviewed per type of FO was different between the two survey steps. In the first survey step, 21 farmers were randomly selected in each treatment FOs and 12 farmers in each control FO in the south of Tanzania. In the second step, which covered the center and north of Tanzania, 19 farmers were randomly selected in each treatment FOs and 12 farmers in each in control FO. Farmer were randomly selected from the most recently updated list of registered members of the FO. A total of 1,933 farmer was interviewed, spread over 108 FOs, from which 975 farmers are located in the south of Tanzania; while the remaining 958 farmers are located in the center or north of Tanzania.

5.2 Survey content

The survey questionnaire is guided by project goals, the WFP results framework, and the IFC GAFSP (Global Agriculture and Food Security Program) M&E framework. Following the example of the Tanzania National Panel Survey, it will collect detailed data on crop practices and will directly report on the causal impacts of the project as defined in the results framework.

A diverse set of outcome variables key for assessing the impact of the FtMA was collected. Detailed data was collected was plot management, maize input decisions, household income sources and behavioral outcomes. A detailed overview of all key outcomes that was collected during the survey is listed in Appendix 13.4. The questionnaire design reflected the key outcome variables, following the design of the Tanzania National Panel Survey.[12] Appendix 13.3 shows an overview of the questionnaire topics. The questionnaire is split up in an agricultural and household level questionnaire. The agricultural questionnaire is based on the LSMS questionnaire, but has been substantially shortened by reducing the number of questions in each section, asking detailed input and sales outcomes only for maize and asking basic input and output questions for other crops. The household questionnaire is also based on the LSMS household questionnaire, but has been extended to also cover behavioral/intellectual outcomes.

[12] Both agricultural and household questionnaires are based on the Tanzania National Panel Survey questionnaires. The agricultural questionnaire has been substantially shortened by reducing the number of questions in each section, asking detailed input and sales outcomes only for maize and asking basic input and output questions for other crops. The household questionnaire has been extended to also cover behavioral/intellectual outcomes. A questionnaire is also administered to the FO.

Half of the questionnaire was devoted to a detailed crop production questionnaire, with main focus on maize production decisions and outcomes. This part of the questionnaire collected data on the uptake of inputs in maize production, level of harvest and sales of maize production, expenditure and knowledge of inputs in maize production, and outcomes of other crop production. This data allows measuring maize yields, income from maize selling, and total farm income. The second part of the questionnaire focused on household level outcomes, i.e. education and health outcomes, livelihood diversification and poverty measures. Detailed data was collected on on-farm labor productivity and income levels, and on income from non-farm household enterprises and non-labor activities. This allows to calculate total household income.

Further attention in the household questionnaire was given to poverty indicators (housing conditions, consumption), food security measures, and gender aspects. To capture the former, the indicators of the Simple Poverty Scorecard of Schreiner (2016) were implemented in the questionnaire. An additional measure of the household's welfare status is the children's nutritional status.[13] We measured (using height boards and scales) the height for age for children under 5 years as a measure of chronic malnutrition, which can be compared between treatment groups and tracked over time. The food security questions were taken from the Food Insecurity Experience Scale (FIES) designed by FAO.[14] A food consumption module was added to be able to calculate the WFP Food consumption score from a standard VAM 7-day food frequency data. Gender sensitive questions are captured by the Scoping Survey Questionnaire IFC's gender mapping tool. Most of the questions in the household level and agricultural sections were asked to household heads directly. However, in the household roster, and linked sections of education, health and labor, data was collected on all household members.[15] Moreover, several questions throughout the questionnaire ask who in the household performs certain tasks or makes decisions.

Finally, a wide set of behavioral outcomes was introduced in the household questionnaire, as the intervention is expected to affect the (non-)cognitive capacities, time and risk preferences, risk perceptions of participating farmers. Furthermore, the IE team also collected information at the FO level by interviewing the FO leaders and at the buyer level with separate questionnaires. This FO level data provided data on (transformation in) maize markets, village prices, FO characteristics and maize marketing. Finally, the I&E team will avail of administrative data collected by the WFP monitoring team. For instance, the first set of research questions regards variables correlated with credit take-up within the treatment group and will be addressed analyzing baseline data matched with the lists of loan/ input takers.

[13] This data was collected during the baseline survey as this indicator is less subject to the timing of the baseline survey and much less time consuming than asking a detailed expenditure module

[14] http://www.fao.org/3/a-i7835e.pdf

[15] Household members are identified as individuals that stayed more than 3 months in the household during the last 12 months

PART II:

MAIN RESULTS

6 Organization of presenting the main findings

In the following sections, we present the baseline data and describe the patterns that are observed in the data. We restrict the presentation to the 'main findings', while more detailed description of the data and additional analysis of data patterns is presented in appendix II. It follows the structure of the most important topics covered in the questionnaire, and each topic contains several sub topics. We start with describing the general characteristics of farmers in the baseline survey. We then proceed by looking at farmers' input decisions and outcomes achieved in maize production. We end with presenting household level data on farmers' livelihood strategies.

Before presenting this data, it is important to provide more details on the methodology used to clean, analyze and report the baseline data.

Level of data analysis. While all indicators are reported at the household level, (some of) the data on maize production is recorded at maize plot level. As several households have more than one maize plot, we aggregate this data at the household level (i.e. calculate the total value over different maize plots). For some indicators, the plot level data is presented in the associated appendix

(sub-) Sample analysis. For several maize input and output indicators, summary statistics can be presented for different samples. For example, input application rates can be presented for the entire sample of farmers, or for the sub-sample that actually applied the input on their maize plot. Similarly, data on maize sales can be reported for the entire sample, or for those that actually sold maize. In essence, this means that for the latter we replace the zeros in the former data by missing values. In some sub-sections we will present both indicators, while for other sections, the indicator for sub-samples are reported in the associated appendices.

Trimming. All the baseline data presented here is based on farmers self-reported recall response. While the data has gone through several rounds of data cleaning and quality checks, in some cases, outliers might still be present in the data. To avoid outliers to bias the summary statistics, we use trimmed values when presenting (most) continuous variables. The trimming procedure used here looks at the distribution of each variable and detects outliers in the top and bottom 1% of the distribution in the sample, and replaces outliers by the median value of the distribution (if any).

Reference period. The reference period of the questions asked in the maize specific section is the long rainy season of the year 2015-2016.[16] More in specific, this includes the data collected on plots that were cultivated by households in the long rainy season or both in the short and long rainy season. To simplify notation, we will refer to both periods as 'long rainy season'. However, other questions are asked for the last 12 months (e.g. number of loans taken), i.e., the 12 months up until when the household was interviewed in November – December 2016. Finally, the food security

[16] The data hence reflects the production decisions and outcomes in the last production year before the FtMA intervention was rolled out. The long rainy season is the major cultivation season in Tanzania for maize.

indicators were collected during a separate field survey in 2018, so these questions refer to the 12 months up to the period that the household was interviewed in June 2018. We will clearly indicate the correct reference period.

Comparability of the data. Maize level data is presented in per hectare term. Monetary values of variables are expressed in USD, using the conversion rate at December 1 2016: 1TSH=0.000460USD (retrieved from xe.com).

Data disaggregation. For several sub-topic of interest, we will do further data analysis by disaggregating the data according to the (i) sex of the household head, (ii) region of residence, and (iii) wealth indicators; to see how gender, geographical or wealth differences affect agricultural outcomes. The gender based disaggregation looks at the sex of the household head (dummy). The geographical difference indicator (dummy) compares farmers living in the south of Tanzania, with those living in the center and north of the country. The household's wealth status is captured by two (self-reported) continues indicators: farm size and the value of agricultural assets. For both indicators, households are categorized according to the quintal to which they belong in the sample distribution. Then, the data (mean values) is presented for each quintal separately. Finally, for some indicators, we will detect whether the difference in mean outcomes between (gender, geographical, and wealth) groups is statistically significant (i.e. different from zero). To do so, we regress the outcome variable on the indicator of gender (dummy), region (dummy) or wealth quintal (categorical) to perform a t-test comparison of means (with clustered standard errors and the first dummy taken as reference).

Most of the disaggregated data analysis is presented in appendices, but some interesting patterns are presented in the main text.

Non-parametric graphs. To make the disaggregation more intuitive, we will also graphically present the evolution of outcomes of interest in function of the value of farm size or value of agricultural assets (natural logs). To do so, we will display the smoothed values (and the 95% confidence interval) of a kernel-weighted local polynomial regression of the outcome of interested on either farm size or agricultural asset value. Such graphs are known as 'local polynomial smooth plots', but we will refer to them as 'non-parametric graphs' in the text.

7 Description of the farmers in the sample

7.1 Demographics and education

Table 7-1 reports the demographics of household head and spouse. Households in the survey sample have on average 6 household members, and the household size ranges from 1 to 20 members (Figure 7-1). On average, 35% of the households have at least one household member below 5 years, and 77% have at least one household member between 5 and 16 years. 84% of the households are headed by a male, which is on average 51 years. 93% of the household heads can read and write any language. 88% of the household heads finished primary school, 21% finished the first year of secondary school and 10% finished secondary school. The spouse of the household head is on average 44 years and 87% of the spouses can write and read any language. 90% of the spouses finished primary school, while 15% of them finished secondary school.

Table 7-1: Demographics of household head and spouse

	Household head (n=1,933)		Spouse (n=1,705)	
Characteristics	Mean	s.d.	Mean	s.d.
Size of the household (number)	5.5	2.3		
Household members below 5 years (number)	0.5	0.7		
Household members between 5 and 16 years (number)	1.7	1.4		
Person is male (%)	84	36	4.9	22
Age of the person (years)	51	13	44	12
Person can read (%)	93	25	87	34
Person can write (%)	93	26	87	34
Person can read and write (%)	93	26	87	34
Person went to 7th year of primary school (%)	88	32	90	30
Person went to 1th year of secondary school (%)	21	41	23	42
Person went to 6th year of secondary school (%)	9.9	30	15	36

Note: 'n' is the number of observation, 's.d.' is the standard deviation

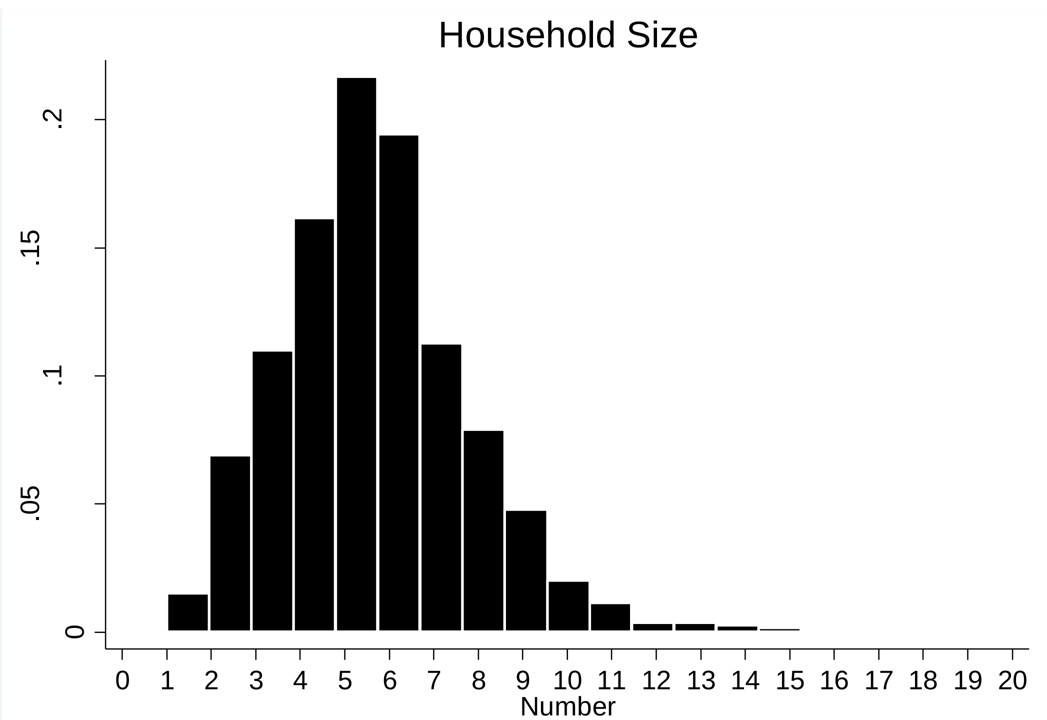

Figure 7-1: Household size

7.2 Simple Poverty Scorecard

Schreiner (2016) has developed a Simple Poverty Scorecard for Tanzania, which is an updated version calibrated on the Tanzania Household Budget Survey data collected in 2011 – 2012.[17] The poverty scorecard is an intuitively understandable and simple-to-program method to estimate the likelihood that a household lives below a certain poverty line. To do so, a score is calculated as the weighted sum of ten poverty indicators – looking at household size (and education), housing quality, household assets, and household livelihood activities.[18] The score can range between zero and 100, and a higher score corresponds with a lower likelihood of households being poor. For each score, the estimated likelihood that a household is below a certain poverty line can then be found through the lookup table for each poverty line provided by Schreiner (2016).

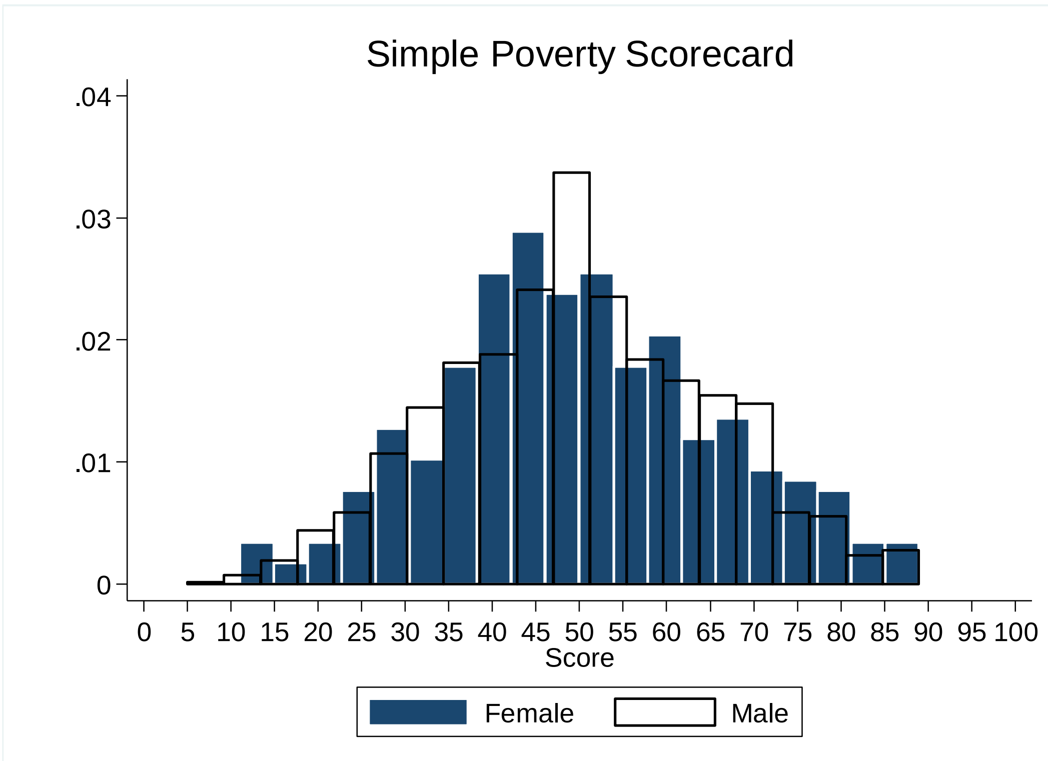

Figure 7-2: Simple Poverty Scorecard

The histogram of the poverty score calculated on the baseline data using the poverty scorecard methodology is plotted in Figure 7-2. The average score of households in Tanzania is 50, but varies from 10 to almost 90. Table 7-2 shows the lookup table of Schneider (2016), where the household counts in each class of poverty scores (with an interval of 5) are added. Using the number of

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[17] Schreiner, Mark. 2016. "Simple Poverty Scorecard® : Tanzania. Available [consulted on 8/11/2018] at http://www.simplepovertyscorecard.com/TZA_2011_ENG.pdf

[18] Appendix 14.1.1. shows more detailed information on farmers' housing conditions

households in each class, and the corresponding likelihood that a household (in each interval) falls below the poverty line, it is estimated that 529 surveyed households live below the international poverty line of 1.9 USD/day (2011 PPP). This corresponds with a poverty rate in the baseline sample of 27%; and this poverty rate is not different between female and male-headed households. Schreiner (2016) reports that – based on the 2011/2012 Household Budget survey– the share of households living under the 2011 PPP poverty line is 39.4% in Tanzania and 48.6% in rural Tanzania. The farmers in the baseline survey are hence relatively better-off farmers compared to other farmers in rural Tanzania.

Table 7-2: Number of poor in FtMA sample based on Schreiner (2016) methodology

	# farm households in the sample			**2011 PPP poverty line of $1.90/day**	**# poor households**		
Score	Females	Males	Total		Females	Males	Total
0–4	0	0	0	100	0	0	0
5–9	0	1	1	100	0	1	1
10–14	4	9	13	89	4	8	12
15–19	2	19	21	85	2	16	18
20–24	8	40	48	78	6	31	37
25–29	15	75	90	70.6	11	53	64
30–34	17	117	134	57.7	10	68	77
35–39	27	146	173	47.2	13	69	82
40–44	41	214	255	31.2	13	67	80
45–49	45	218	263	28.5	13	62	75
50–54	32	176	208	18.8	6	33	39
55–59	30	182	212	11.9	4	22	25
60–64	24	158	182	5.8	1	9	11
65–69	19	99	118	3.7	1	4	4
70–74	12	82	94	3.1	0	3	3
75–79	12	43	55	2.9	0	1	2
80–84	8	33	41	1.3	0	0	1
85–89	6	19	25	1.2	0	0	0
90–94	0	0	0	0	0	0	0
95–100	0	0	0	0	0	0	0
Total	302	1631	1933		**83**	**447**	**529**
Relative					**27.43**	**27.38**	**27.39**

7.3 Household shocks and food security indicators

Households in the survey sample were asked whether and which types of shocks the household experienced during the last 12 months. Table 7-3 gives an overview. 55% of the households reported that they experienced at least one shock during the last 12 months, but female headed households on average experience more shocks.[19] The following five shocks were reported by the households in the survey sample to occur most frequently: livestock died or were stolen (24%), the death of a household member (22%), rise in agricultural input prices (20%), large fall in crop prices (19%), and large rise in food price (18%).

Table 7-3: Recent shocks to the household

Region	Whole sample (N=1,933)		Male headed (N=1631)		Female headed (N=302)		
% of households that faced…	Mean	s.d.	Mean	s.d.	Mean	s.d.	Diff is sign.
At least one shock occurred to the household last year	55	50	53	50	63	48	***
Type of shock?							
Livestock died or were stolen	24	43	23	42	25	43	
Death of other family member	22	41	21	41	25	43	
Large rise in agricultural input prices	20	40	19	40	21	41	
Large fall in sale prices for crops	19	39	19	39	19	39	
Large rise in price of food	18	39	18	39	19	39	
Chronic/severe illness or accident of household member	6.1	24	5.6	23	8.6	28	*
Death of a member of household	5.7	23	4.5	21	12	33	***
Household business failure, non-agricultural	4.1	20	3.7	19	6.6	25	*
Break-up of the household	2.5	16	2.1	14	4.6	21	**
Hijacking/Robbery/burglary/assault	1.4	12	1.3	11	2	14	
Dwelling damaged, destroyed	1	10	0.9	9.5	1.7	13	
Loss of salaried employment or non-payment of salary	0.7	8.2	0.6	7.8	1	9.9	
Loss of land	0.7	8.2	0.7	8.2	0.7	8.1	

Note: 'n' is the number of observation, 's.d.' is the standard deviation. 'sign. Diff.?' refers to the significant difference in mean value of the outcome specified in each row between male and female headed households. These are obtained from the regression of the outcome variable on the gender dummy, where the first dummy is taken as reference. The stars refer to the level of significance: $*p<0.10$, $**p<0.05$, $***p<0.01$, no star: insignificant difference.

The household (heads) in the survey sample were also inquired about several food security issues that might have occurred to the household over the last 12 months.[20] The results are reported in Table 7-4, and the food security questions are sorted according the FIES order of questions. First, 27% of the survey households responded affirmative that their family worried about not having enough food. Second, about half of the households indicates that they have consumed unhealthy or only a few kinds of foods during the last 12 months. Third, 22% and 13% of the households respectively had to eat less that they thought they should or had to skip a meal; while 28% of the households ran out of any kind of food. Forth, about 10% of the households went without eating for a whole day or hungry during the last year. The likelihood that one of the FIES indicators

[19] Appendix 14.1.2 further suggests that households in south of Tanzania and central and north experienced differential shocks, e.g. the south of Tanzania experienced less food price increases, but the differences are not very large.

[20] This data is based on the food security baseline survey conducted in June 2018.

occurred in the household does not change between male and female-headed households (the last column of Table 7-4). In appendix 14.1.2, further disaggregation over region and wealth is presented.

Table 7-4: Food Insecurity Experience Scale (FIES) indicators

Share (%) of households that experienced…		all farmers (n=1,593)		Male (1,340)		Female (253)		Sig. Diff
		Mean	s.d.	Mean	s.d.	Mean	s.d.	
FIES 1	Worry you would not have enough food to eat?	27	44	27	44	25	44	no
FIES 2	Eat unhealthy and not-nutritious food?	53	50	53	50	53	50	no
FIES 3	Eat only a few kinds of foods?	50	50	50	50	48	50	no
FIES 4	Eat less than you thought you should?	22	42	22	42	21	41	no
FIES 5	Skip a meal?	13	34	13	34	13	34	no
FIES 6	Ran out of food of any kind?	28	45	27	45	30	46	no
FIES 7	Go without eating for a whole day?	9	29	9	29	9	29	no
FIES 8	Be hungry but did not eat?	11	31	11	31	11	31	no

Note: 'n' is the number of observation, 's.d.' is the standard deviation. 'sign. Diff.?' refers to the significant difference in mean value of the outcome specified in each row between male and female headed households. The stars refer to the level of significance: ∗p<0.10, ∗∗p<0.05, ∗∗∗p<0.01, no: insignificant difference.

Statistical validation of the food security data collected by the FIES module is based on the methodology described by FAO (2016).[21] The fit of the Rasch model is above 0.7, which indicates that the model to estimate of food (in)security indicator used by the FIES method fits the data well.[22] Figure 7-3 shows the total number of FIES issues that a household faced during the last 12 months, also called the household's 'raw score'. Households on average faced two food security issues, but 34% of the households indicate that they did not experience any food security issue. 11% of the households had only one type of food security issue described in the FIES indicators, and 22% faced two food security issues. The remaining 22% of the households faced three or more food security issues. FAO (2016) describes the methodology to calculate the prevalence rate of food security that are globally comparable based on the raw scores. Using this methodology, it is estimated that the prevalence of moderate and severe food security is respectively 27% and 1% in the baseline survey sample.

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[21] FAO. 2016. Methods for estimating comparable rates of food insecurity experienced by adults throughout the world. Rome, FAO. http://www.fao.org/3/a-i4830e.pdf.

[22] More precisely, the Rasch Reliability statistic of 0.76 exceeds the threshold of 0.7. To perform the Rasch Reliability test, several assumptions need to be verified. The number of non-extreme cases (969) exceeds the minimum of 100. The assumption of equal discrimination is valid based on infit statistics between 0.7 and 1.1 (which are considered as acceptable and excellent) and outfit statistics that never exceed 1.7 (which is below the acceptable threshold of 5). The assumption of unidimensionality is also valid, since the maximum residual correlation (of any item pair) does not exceed the value of 0.4.

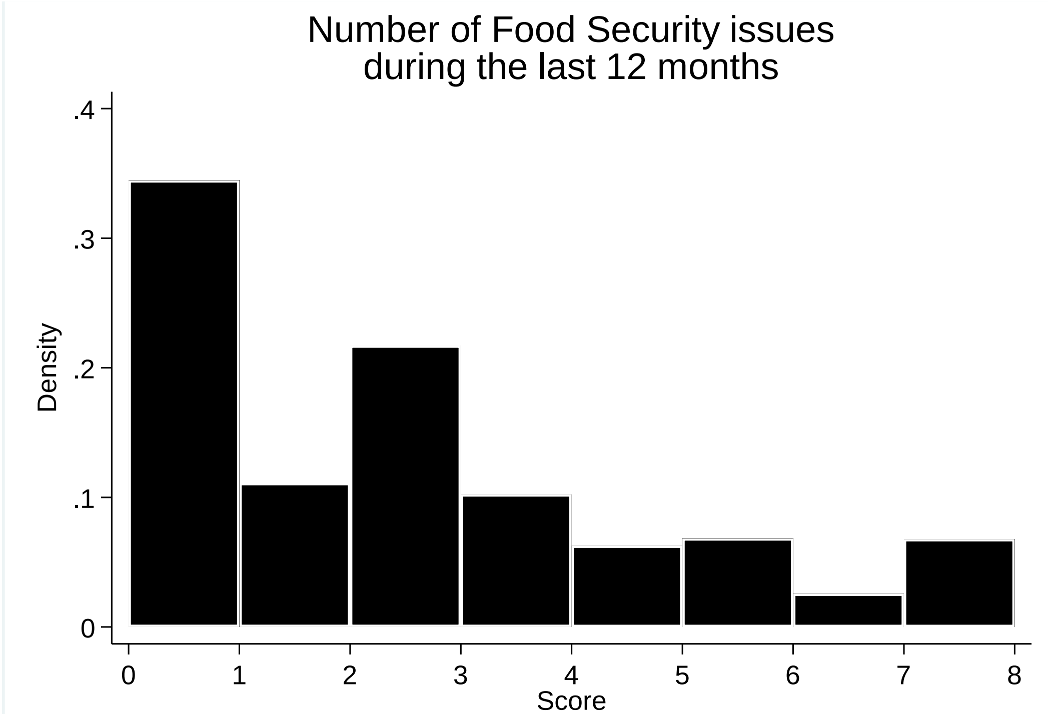


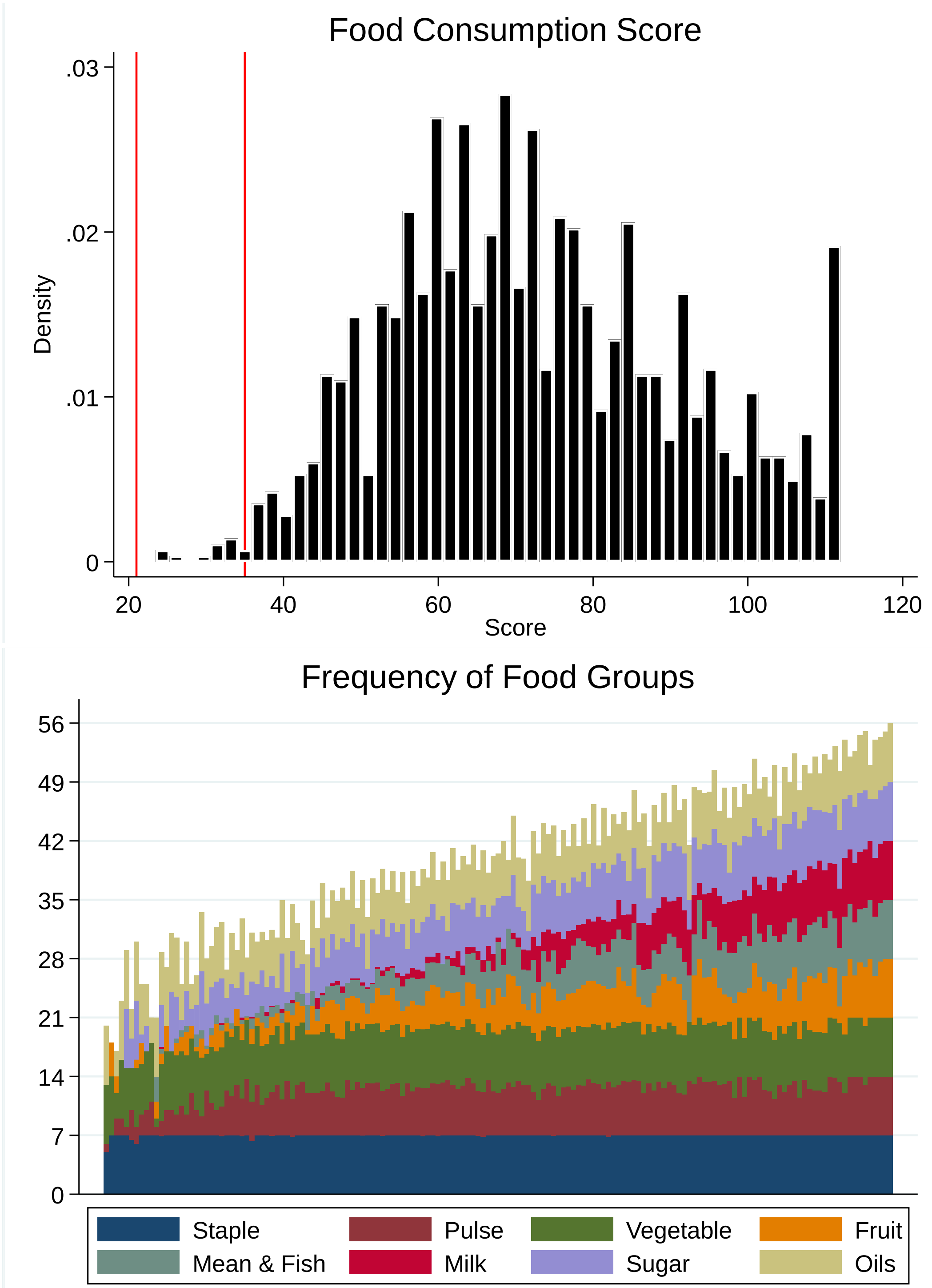
Figure 7-3: Frequency of food security issues listed by FIES faced by households

We finally collected data on the food consumption habits of households in the baseline survey. For different food items (grouped in food groups), the frequency of consumption (by anyone in the household) and total amount consumed during the last 7 days was asked. The data is analyzed using the Food Consumption Score (FCS) methodology developed by WFP (2008), which is an indicator of food access and nutrition intake.[23] The FCS score is calculated as the weighted sum of the consumption frequency (per week) for the different food groups. WFP (2008) proposes two food consumption thresholds: a household with FCS below 21 is considered to have poor food security, a household with FCS between 22 and 35 has borderline food security, and a household with a FCS above 35 has an acceptable food security.

The first graph of Figure 7-4 shows the histogram of the FCS calculated on the baseline data, where red lines represent respectively the FCS thresholds of 21 and 35. According to the FCS methodology, food security does not seem to be problematic for farmers in the baseline survey, as none of the households has a poor food consumption, 0.8% has borderline food consumption, and the large majority (99.2%) of households has an acceptable food consumption status. The second graph of Figure 7-4 shows the cumulative frequency of consumption per food group (number of days per week for each food item), and over the FCS (on the x-axis). Nearly all households consume

[23] World Food Programme (WFP). 2008. Food consumption analysis: Calculation and use of the food consumption score in food security analysis. https://documents.wfp.org/stellent/groups/public/documents/manual_guide_proced/wfp197216.pdf

staples every day, and consume pulses and vegetables regularly. With increasing FCS, more fruits, meat and fish, and milk products are consumed by households.



Notes: the x-axis in the bottom graph is the same score as in the upper graph

Figure 7-4: Food Security Score (FCS) and frequency of food groups following WFP (2008)

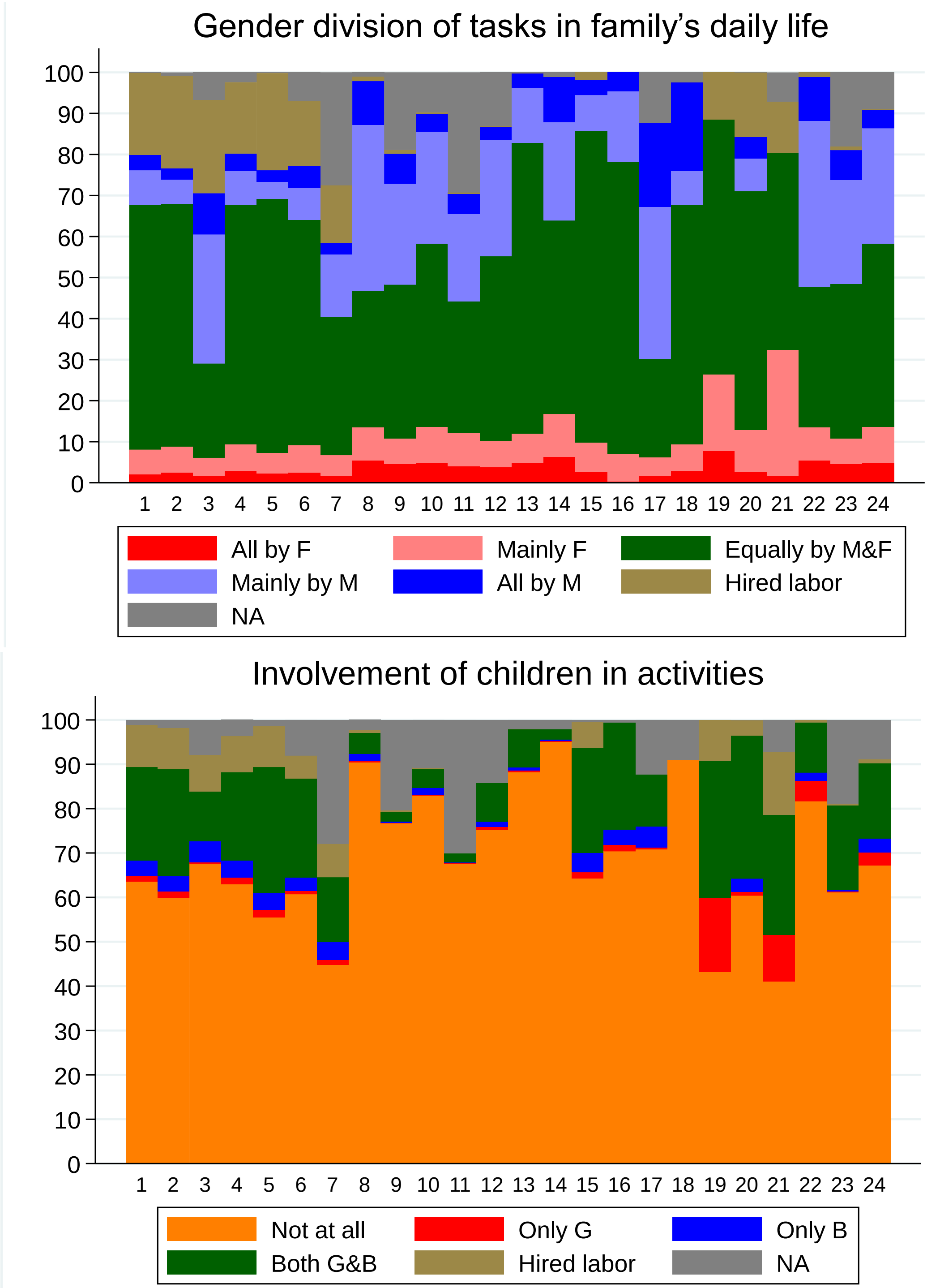
7.4 Household decision making

Gender disaggregated questions were asked about who within the household (males, females, children) performs certain (household) tasks, who has access to resources (and their benefits), and who makes decisions in the household; following IFC's gender mapping tool. Appendix 14.1.3 presents detailed tables with shares for each activity/resource considered, but we limit the data description here to graphs showing cumulative frequencies of the different answer options.

The first graph of Figure 7-5 below shows the cumulative frequency that a certain task is performed exclusively, mainly, or jointly by males and females in the household. The different tasks asked to respondents are presented on the x-axis following this numbering

1	Land preparation	13	Participation in community meetings
2	Weeding	14	Participation in meetings at the cooperative
3	Chemical spray	15	Participation in trainings
4	Fertilizing	16	Ownership of agricultural land
5	Harvesting	17	Ownership of family bank account
6	Post harvesting activities	18	Ownership of housing
7	Maize Transportation to collecting point	19	Cooking
8	Purchasing agricultural inputs	20	Housekeeping (cleaning, washing, ironing, etc.)
9	Hiring labor	21	Child caring
10	Selling of maize	22	Shopping (buying household goods)
11	Taking credit/loan	23	Gardening(self-consumption kitchen garden)
12	Land agreement /contract with Mills	24	Animal/livestock caring

For most activities, households share the responsibility to perform the task equally between males and females. Males, however, are relatively more responsible for applying chemical spray and for hiring (agricultural) labor. The second graph of Figure 7-5 shows that while child involvement in general is small for most activities, both girls and boys are involved in agricultural activities for some households.



Note: Female = F, Male = M, Girls = G, Boys = B, Hired labor = household outsources task to hired labor, NA = Non Applicable.

Figure 7-5: Gender disaggregated performance of tasks within the household

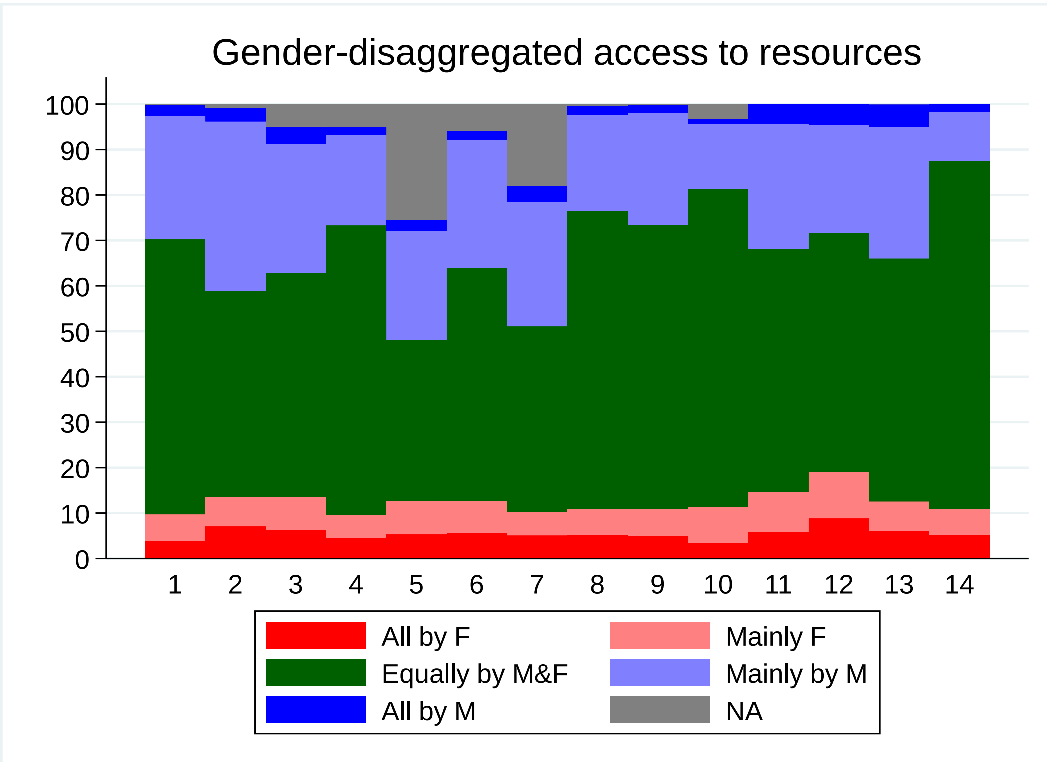
Figure 7-6 shows how the access to household resources changes over gender, and who in the household makes decisions about these resources. The resources that were considered are:

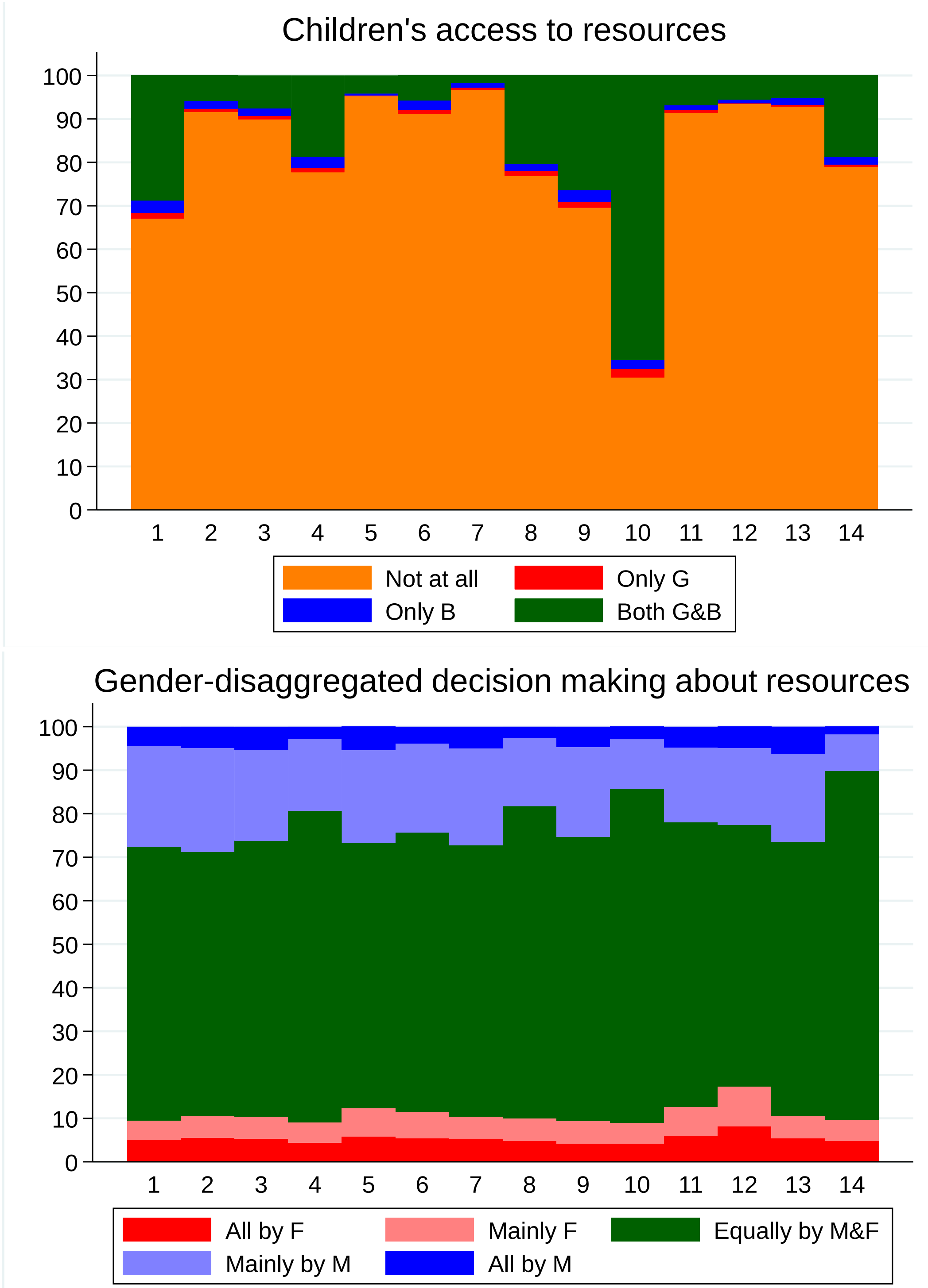
1 Land

8 Income

2	Agri. Inputs (fertilizer, pesticide)	9	Fixed asset (e.g. house, motorcycle)
3	Extension and training	10	Education for children
4	Technology	11	Expenses on food
5	Credit/Loan	12	Expenses on non-food
6	Marketing/Selling Farm Organizations	13	Expenses on maize farming
7	Labor	14	Social activity

The first graph shows that for nearly all resources, access is equally shared by males and females in the household. Access to agricultural inputs and farm organizations however seems to be relatively higher for males. The second graph shows that children do not have (a lot of) access to most resources, and if they do (most notably for education), both boys and girls in the household have equal access. The last graph shows that decision making about resources in the household is equally done by males and females.





Note: Female = F, Male = M, Girls = G, Boys = B, Hired labor = household outsources task to hired labor, NA = Non Applicable.

Figure 7-6: Gender disaggregated access to resources and benefits

8 Maize production

In this section, we characterize the maize production of farmers that were covered in the survey. In the questionnaire, there was an extensive section on input usage for maize plots in specific. There are 1,885 households that cultivated maize during (i) only long rainy season or (ii) both long and short rainy season.[24] Because households have one or more maize plots, we have information on 2,143 plots. The discussion here focusses on the main indicators of maize production, i.e., input application, input cost, harvest and income in maize production. A more detailed description of the maize production of baseline farmers is provided in Appendix 14.3 – 14.5

8.1 Farm size

Farm size in Table 8-1 is calculated by aggregating all plot (sizes) as reported by households in the plot roster, both maize and non-maize plots. The mean value of the trimmed farm size is 2.1 hectare, while the median value is on average lower at 1.4 hectare. The farm size of male-headed households is 34% larger than female-headed households, and this difference is statistically significant different from zero (results from the t-test not shown). Figure 8-1 shows the distribution (and kernel distribution in dotted line) in the self-reported (trimmed) farm size data, which ranges from 0.2 hectare to 20 hectare.

Table 8-1: Self-reported (trimmed) farm size

Total farm size (ha)	N	Mean	s.d.	Median	Min	Max
All households	1,933	2.1	2.3	1.4	0.2	20
All households - Male heads	1,631	2.2	2.4	1.6	0.2	20
All households - Female heads	302	1.7	1.7	1.2	0.2	14

Note: 'n' is the number of observation, 's.d.' is the standard deviation, 'min' is the minimum, 'max' is the maximum

[24] Hence 48 households are missing because (i) 9 households have reported no maize plots in plot roster section, (ii) 2 households did not cultivate the maize plots on their own plots, (iii) 37 households cultivated maize only in the short rainy season

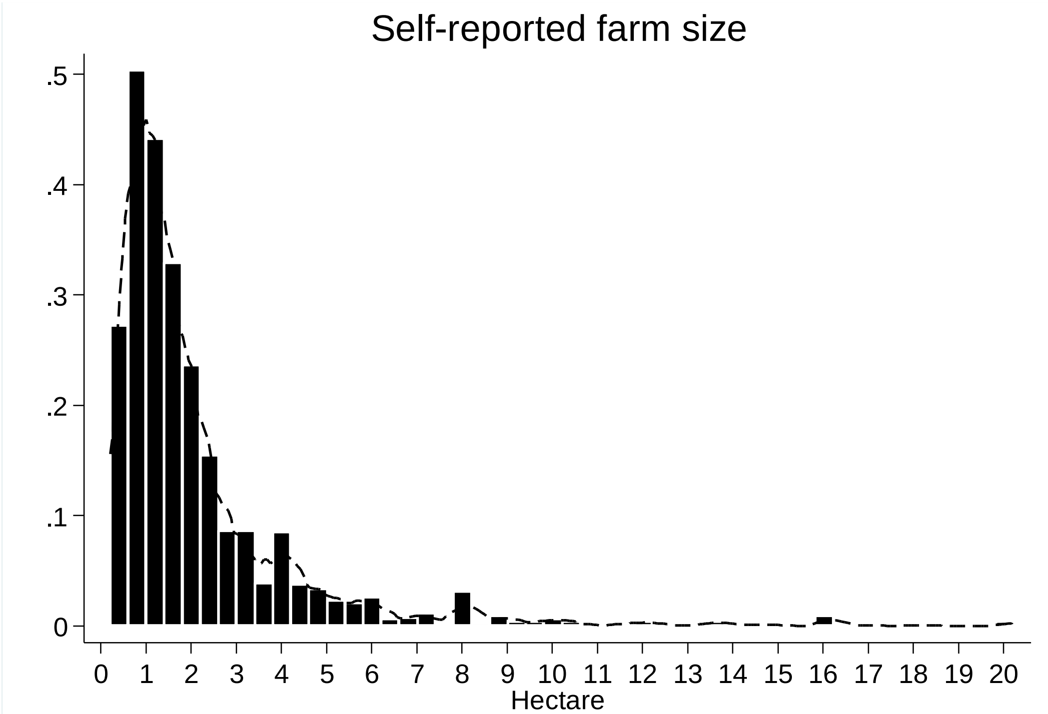


Figure 8-1: Self-reported and trimmed farm size (hectare)

Appendix 14.3.1 presents more data on farm sizes (and maize cultivation size) disaggregated according to region and wealth. Two important observations are that (1) plot sizes in the central and north of Tanzania are on average half a hectare larger compared to the south; and (2) total farm size is positively related with asset value. The latter is shown in Figure 8-2.

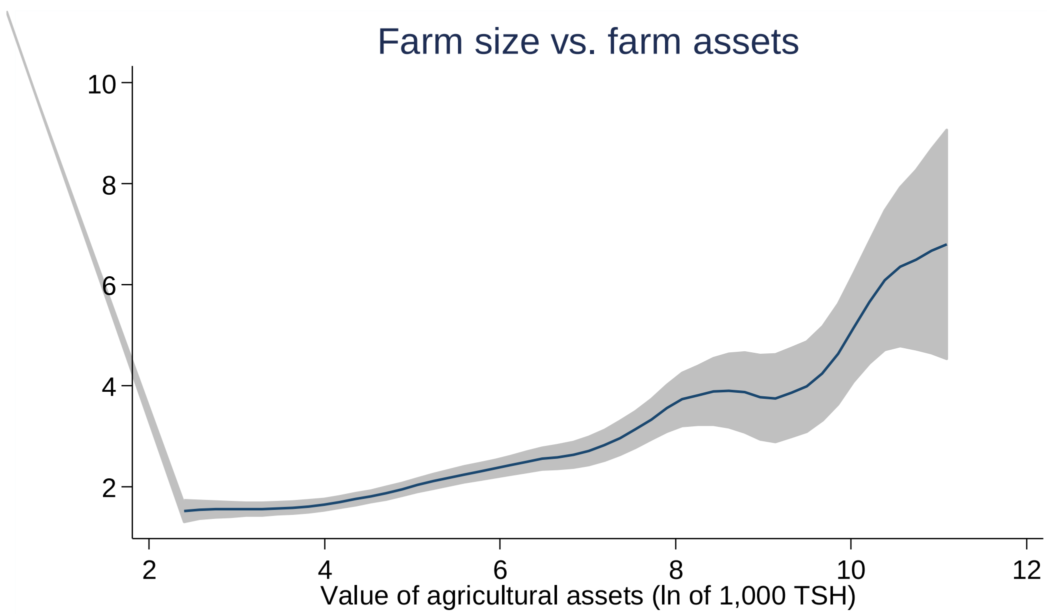


Figure 8-2: Farm size (hectare) versus value of agricultural assets

8.2 Maize cultivation size

Maize area under cultivation is calculated by aggregating the size (hectare) of all maize plot (if more than 1) as reported by households in the plot roster of the questionnaire. In fact, 72% of all plots reported by the households is cultivated with maize. Table 8-2 shows that the area of land cultivated with maize is on average 1.8 hectare per household, and the median value is 1.2 hectare per household. Figure 8-3 shows the distribution of the size of maize cultivated by the baseline households. Appendix 14.3.1 documents the disaggregated data on maize cultivation size over region and asset value. Appendix 14.2.1 shows that some of the maize crops are intercropped with beans or pigeon peas, for the reason to have a cash crop or substitute for consumption.

Table 8-2: Size of land cultivated with maize per household

Total area cultivated by maize (ha)	N	Mean	s.d.	Median	Min	Max
All households that grow maize	1,885	1.8	2.0	1.2	0.2	16
All households that grow maize - Male heads	1,589	1.8	2.1	1.2	0.2	16
All households that grow maize - Female heads	296	1.4	1.5	0.8	0.2	13

Note: 'n' is the number of observation, 's.d.' is the standard deviation, 'min' is the minimum, 'max' is the maximum

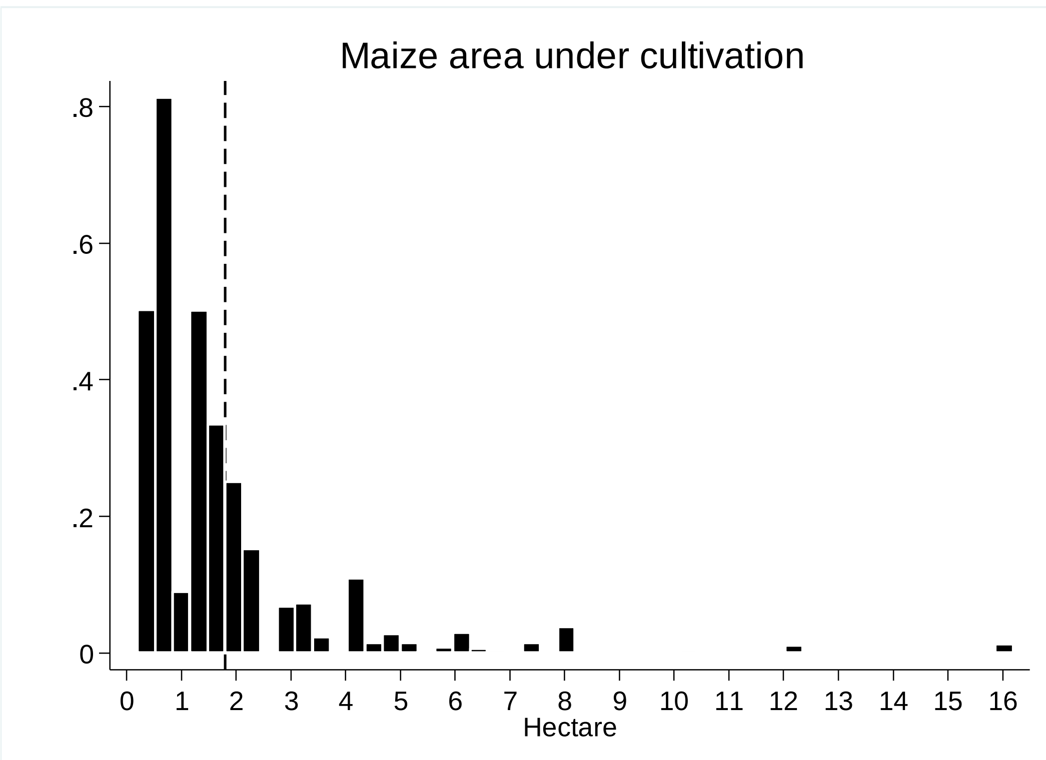


Figure 8-3: Histogram of size of maize cultivated by the household

Appendix 14.3.2 documents more information on the characteristics of the plots of the household. Agricultural plots are owned by households, without ownership certificate. The source of water on these plots is mainly rain-fed, and half of the households have some type of erosion control on their plots.

8.3 Modern inputs

The modern inputs in maize production we consider are maize seeds, inorganic fertilizer (P, N, and NPK type of fertilizer) and pesticide (insecticide, fungicide or herbicide).[25] The first two columns in Table 8-3 report whether the household used the input (in percentages of household used), while the third to eight column report the summary statistics for the application rates for maize growing households. All application rates are reported in relative terms (unit per hectare), for all farmers (hence missing values are replaced by zeros), and trimmed.

Half of the households used improved maize seeds on their maize plots, and the average application rate is 9 kg per hectare. Appendix 14.2.2 provides more information about the plot level seed usage. 58% of the households used any type of inorganic fertilizer, and the average application rate is 107 kg per hectare. Disaggregating over type of fertilizer, 44% of the households used N fertilizer and 36% of the households used P fertilizer, respectively at a rate of 72 kg per hectare and 35 kg per hectare. 29% of the households used any type of pesticide, with an average application rate of 0.6 liters per hectare. Herbicide (17%) and insecticide (16%) are the most commonly used pesticides. Appendix 14.2.3 documents the disaggregated summary statistics for input application, where some important patterns over region and wealth are observed (see also section 9.1).

Table 8-3: Application of modern inputs in maize production

Input application (N=1,885)	Household used input (%)		Application rates				
	Mean	s.d.	Mean	s.d.	Median	Min	Max
Improved maize seeds (kg/ha)	54	50	9.1	11	4	0	49
Any type of inorganic fertilizer (kg/ha)	58	49	107	121	74	0	494
P inorganic fertilizer (kg/ha)	36	48	35	56	0	0	247
N inorganic fertilizer (kg/ha)	56	50	72	85	41	0	371
NPK inorganic fertilizer (kg/ha)	1	12	0.08	1.3	0	0	35
Any type of pesticide (l/ha)	29	45	0.6	1.2	0	0	10
insecticide (l/ha)	16	36	0.2	0.6	0	0	4.9
fungicide (l/ha)	1	10	0	0	0	0	0
herbicide (l/ha)	17	38	0.3	0.9	0	0	4.9

Note: 'n' is the number of observation, 's.d.' is the standard deviation, 'min' is minimum, 'max' is maximum

[25] N, P and NPK fertilizer refer to fertilizer products where the main component is respectively Nitrogen, Phosphate or a combination of Nitrogen, Phosphate and Kalium

8.4 Labor usage and mechanization

Detailed questions about labor inputs on the maize plots were asked in a separate questionnaire section. Table 8-4 reports the summary statistics of the labor applied by households in man-days per hectare.[26] We distinguish labor that was supplied by the household themselves ('family') and labor hired in from outside the household ('hired'). For family labor, we also distinguish between the labor supplied by females, males and children. Finally, we also distinguish between different activities in maize production, i.e., preparation of the maize plot (tilling), weeding and application of inputs (fertilizer, etc.), harvesting maize, and post harvesting of maize.

Households on average spend 66 man-days of labor per hectare of maize. 79% of this labor is supplied by the family, while the remaining 21% of the labor is done by workers hired in by the household. 43% of the family labor is supplied by the female, and 38% by males in the household. If we look at specific activities in maize production, we see that in total, weeding and application of inputs in maize production is the most labor intensive task (23 man-days per hectare), followed by preparation of the maize plot (19 man-days per hectare). Relatively more labor is hired in for weeding and input application compared to other activities.

Table 8-4: Allocation of labor over different sources and activities in maize production

Labor usage (mandays per ha) - N=1,885	**Hired**		**Family**		**Total**	
	Mean	s.d.	Mean	s.d.	Mean	s.d.
Labor supplied by…	14	36	52	59	66	69
Gender allocation of family labor						
Labor supplied by females			23	26		
Labor supplied by males			20	25		
Labor supplied by children			10	21		
Labor allocation per maize activity						
Preparing maize plot	3	7	16	22	19	24
Weeding and input application	5	10	17	25	23	41
Harvesting maize	3	6	12	17	15	17
Post harvesting maize	1	3	8	14	9	15

Note: 'n' is the number of observation, 's.d.' is the standard deviation

Appendix 14.2.4 reports the disaggregated data for labor input in maize production. The most notable pattern seems to be the negative relationship between labor supply and farm size, as illustrated in Figure 8-4.

[26] Man-day is defined as the number of days worked on the maize plot by an individual member of the household.

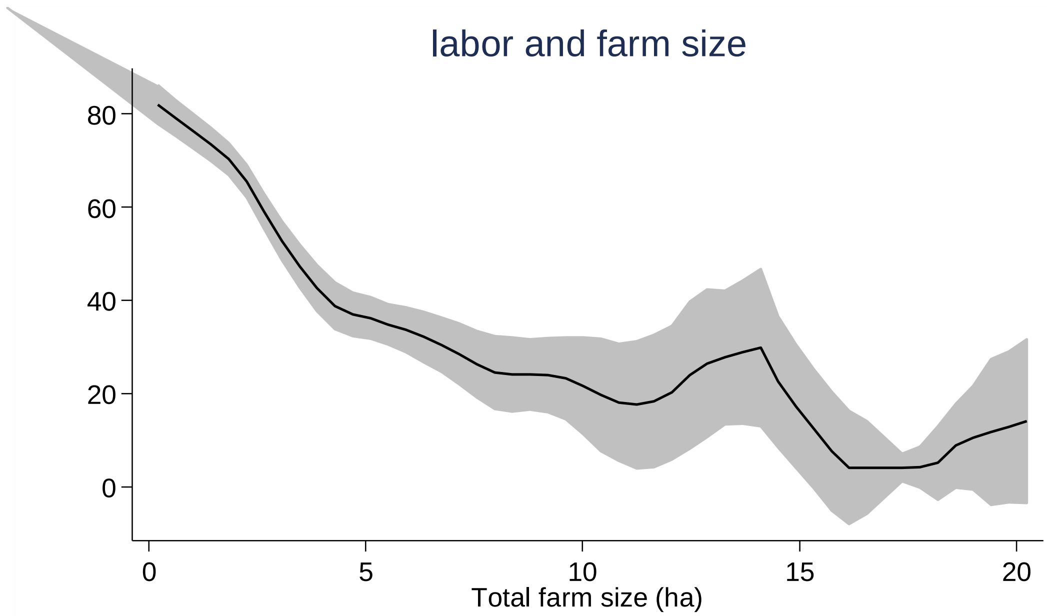


Figure 8-4: Non-parametric graph of labor applied (man-days/ha) in function of farm size

Maize production is partly mechanized, as illustrated in Table 8-5. 48% of the households use mechanized equipment for any of the processes involved in maize production. Mechanized power is mainly applied for tilling the soil (29%) and transporting maize after harvest (29%). Table 8-5 also documents on the ownership of mechanized equipment in maize production for those households that used mechanized equipment. We restrict the analysis to the ownership of any mechanized equipment in maize and the maize activities that were mostly mechanized, i.e. tilling and transporting. On average, only 17% of the households own the machines they use in maize production, and for tilling the soil this is even lower (13%).

Table 8-5: The uptake and ownership of mechanized equipment in maize production

Mechanization	N	Mean	s.d.
Farmers used mechanized equipment for …			
Any maize process (%)	1,885	48	50
Tilling the soil (%)	1,885	29	46
Weeding (%)	1,885	2	15
Constructing seedrows (%)	1,885	8	27
Harvesting maize (%)	1,885	1	9
Transporting maize (%)	1,885	29	45
Farmers own mechanized equipment used in….			
Any maize process (%)	904	17	38
Tilling the soil (%)	552	13	34
Transporting maize (%)	551	17	37

Note: 'n' is the number of observation.

Appendix 14.2.5 shows the uptake and ownership of mechanized equipment in maize production disaggregated over gender, region, and wealth indicators. Most importantly to note is that mechanized equipment is likely to be used and owned by households with higher value of the wealth indicator. Figure 8-5 shows the probability to have any process in maize production mechanized in function of farm size, and shows a generally increasing probability to use mechanization in maize production with increasing farm size.

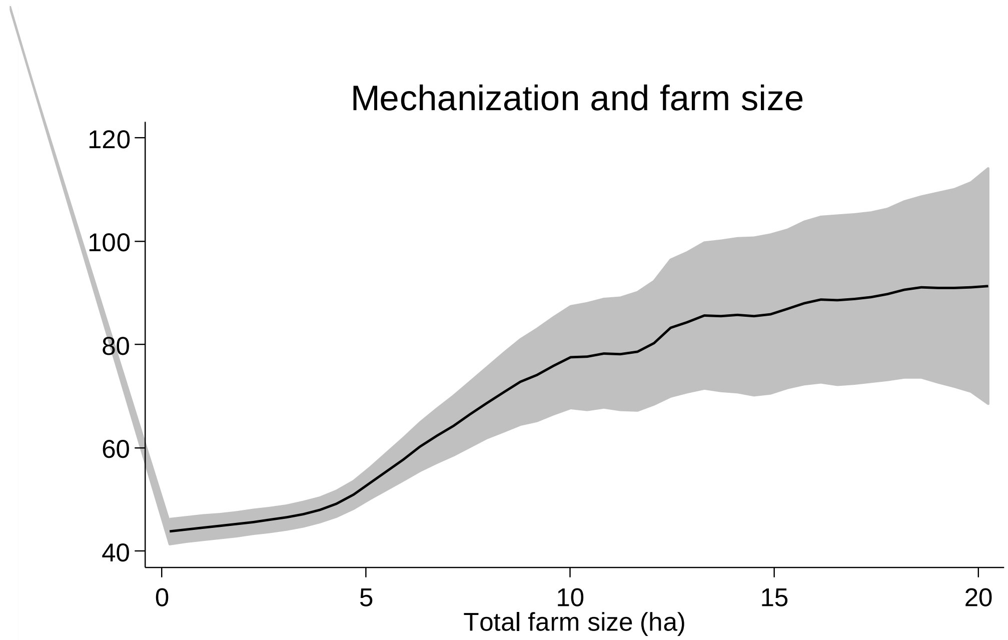


Figure 8-5: Non-parametric graph of mechanization uptake in function of farm size

8.5 Maize output and yield

Data was collected on the quantity of maize harvested by maize producing households and reported in Table 8-6. 97% of the FtMA households (will) harvest maize.[27] The output (metric ton of maize) and yield (output per hectare of land) these farmers obtained on their maize lands is reported in the first panel of Table 8-6. On average, the (trimmed) output achieved on maize plots is 3.3 tons. In relative terms, (trimmed) maize yield is 2.2 tons per hectare. The distribution of maize yield is shown in Figure 8-6, and the non-zero values range from 100 kg per hectare to 9,500 kg per hectare. The second panel of Table 8-6 shows how households allocated the harvested maize to different

[27] However, a lower number (88%) of the households responded to have harvested maize at the time of the baseline survey. Some households grew maize but did not harvest at the time of the interview because their maize output was still at the plot. Hence, their (potential) harvest is not zero, and we have imputed their maize harvest output based on a regression approach, where we model the amount of maize produced based on the inputs applied, plot characteristics and shocks at the plot level. There are 62 households that grew maize but did not harvest because the maize on the plot was damaged, and for these households we assume that harvest was zero.

uses (i.e., the maize balance). On average, 43% of the maize is used for consumption, while 39% is sold at the market. 15% of the total maize production is stored in a storage facility.[28]

Table 8-6: Output harvested, yield and maize balance on the maize plots

Maize output	N	Mean	St. Dev.	Median	Min	Max
Household harvested maize (%)	1,885	97	18	100	0	100
Maize harvest (ton)						
Household that harvested	1,885	3.3	4.0	2.2	0	30
Household that harvested - Male heads	1,589	3.5	4.1	2.2	0	30
Household that harvested - Female heads	296	2.8	3.5	1.6	0	25
Maize yield (ton/ha)						
Household that harvested	1,885	2.2	1.6	2.0	0	9.5
Household that harvested - Male heads	1,589	2.2	1.6	2.0	0	9.5
Household that harvested - Female heads	296	2.1	1.5	1.9	0	8.6
Maize balance						
Share (%) of harvest used for …						
… home consumption	1,657	43	33	33	0	100
… storage	1,657	15	24	0	0	100
… paying off debts	1,657	1.5	6.6	0	0	67
… sales at market	1,657	39	34	40	0	100
… seed	1,657	0.5	2.3	0	0	38
… animal feed	1,657	0.1	1.5	0	0	39
… gifts	1,657	1.1	4.8	0	0	60

Note: 'n' is the number of observation, 's.d.' is the standard deviation, 'min' is the minimum, 'max' is the maximum

[28] Note that the number of observations in the maize balance is lower than the number of maize growing farmers, as this data was only asked for those farmers that harvested maize at the time of the baseline survey.

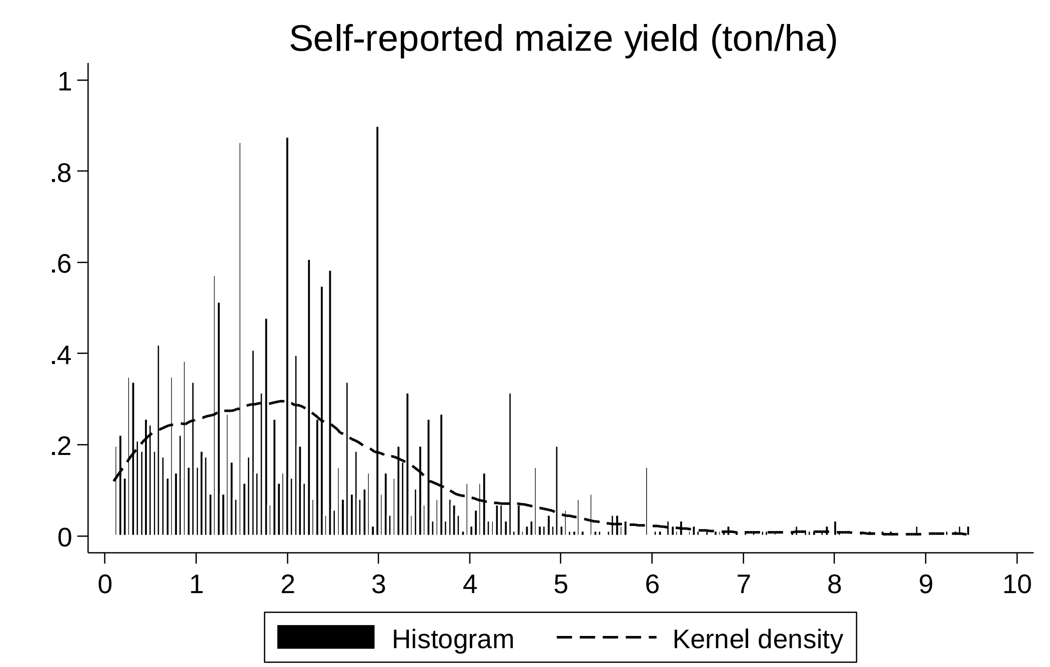


Figure 8-6: Distribution of maize yields (histogram and density)

8.6 Post-harvest handling of maize

The final section of the maize production questionnaire asked farmers about their post-harvest handling of maize. Table 8-7 summarizes the post-harvest processes of farmers that harvested maize. 90% of the farmers dried the maize and this was mostly done in the field and using solar energy. Almost all farmers shelled their maize, and most of these farmers did so manually (55%) or using a motorized tool (44%). 80% of the maize was cleaned, and the main method for cleaning is sieving (69%). 73% of the farmers that harvested maize stored it. The main reason for doing so is for future household consumption (84%); while only a small part of the farmers (12%) responded that they stored maize for selling it later at a higher price. The maize was mainly stored at the household or with their family.

Table 8-7: Post-Harvest Handling of maize

Post-Harvest Handling	N	Mean	s.d.
Maize was dried (%)	1,657	90	30
Maize was dried at field (%)	1,487	91	29
Maize was dried in the sun (%)	1,487	95	21
Maize was shelled (%)	1,657	100	4.3
Maize was shelled manually (%)	1,657	55	50
Maize was shelled with motorized tool (%)	1,657	44	50
Maize was cleaned (%)	1,657	80	40
Maize was cleaned by winnowing (%)	1,324	17	37
Maize was cleaned by sieving (%)	1,324	69	46

Maize was cleaned by motorized tool (%)	1,324	6.7	25
Maize was stored (%)	1,657	73	44
Maize was stored for household consumption (%)	1,215	84	37
Maize was stored to sell later (%)	1,215	12	33
Maize was stored at home (%)	1,215	88	33
Maize was stored with family (%)	1,215	9.0	29
Maize was stored in warehouse (%)	1,215	2.6	16
Stored maize was protected (%)	1,215	64	48
Maize was protected with insecticide (%)	781	96	20

Note: 'n' is the number of observation, 's.d.' is the standard deviation

From farmers who indicate to have some maize stored at the time of interview, 23% expects to lose maize in their storage facility because the maize is rotten, eaten by insects or animals, etc. These farmers expect to lose on average 18 kg of maize, which corresponds to 1.2% of the total maize output. If we assume that farmers who did not store also did not face losses during storage, the expected quantity of maize losses in storage amounts to 12 kg or 0.9% of the maize harvest.

Table.4: Post-Harvest behavior in maize farming

Post-Harvest storage losses	N	Mean	s.d.	Median	Min	Max
Maize was stored (%)	1,657	73	44	100	0	100
Farmer expects to lose maize in facility (%)	1,215	23	42	0	0	100
Expected quantity of maize lost (kg) - if maize was stored	1,215	18	62	0	0	600
Expected quantity of maize lost - all maize harvesting farmers	1,657	12	44	0	0	480
Share of maize expected to be lost (%) - if maize was stored	1,215	1.2	6.0	0	0	100
Share of maize expected to be lost - all maize harvesting farmers	1,657	0.9	5.2	0	0	100

Note: 'n' is the number of observation, 's.d.' is the standard deviation, 'min' is the minimum, 'max' is the maximum

Appendix 14.2.8 provides qualitative information on the type of storage facility used by households that store maize. Most farmers use a storage facility that is consider to be 'improved' over traditional facilities. Most farmers use an improved storage facility because it improves the quality and quantity of the maize stored, less so for selling it at a higher price later in the season.

8.7 Farmers' knowledge and access to extension

62% of the households in our sample received (any source of) extension advice about agricultural activities during the last production season. In Table 8-8, the different sources of extension are displayed, and for each source the percentage of household receiving the service and how they rate the service are displayed. 26% of the households received advice from the farmer organization they belong to, 24% received agricultural advice from their neighbor, and 22% of the household received agricultural information from media sources. Most of the farmers were satisfied with service provided by these extension sources, as the majority of farmers assess the extension service to be of good quality (ranging from 72% for local input supplier to 92% for village demonstration plots). Finally, the last two columns show that in most of the cases, only one on-site visit was received by the household.

Table 8-8: Access to and satisfaction with extension services

Access to extension	Household received extension from (%)		Extension service was rated good (%)		Numbers of on-site visits received by farmers	
	mean	s.d.	mean	s.d.	mean	s.d.
Government extension	17	37	86	35	0.9	1.6
NGO	12	32	80	40	0.5	1.6
Cooperative/Farmer's Association	26	44	83	37	0.9	1.8
Large Scale Farmer	3.3	18	80	41	1.0	1.4
Village demonstration plots	11	31	92	28	1.1	1.6
Community meetings	16	37	78	41	0.7	1.3
Media (radio.tv)	22	42	79	41	1.2	2.7
Input supplier/agro-dealer	12	33	72	45	0.3	6.6
Neighbor	24	43	81	39	1.8	2.6

Note: 's.d.' is the standard deviation

While Table 8-8 showed that over 60% of the surveyed farmers have access to extension and they in general appreciate the agricultural service received, there are many other sources of information that farmers consult when obtaining and consulting (new) information. Therefore, Table 8-9 reports how farmers obtain information for different inputs (improved seeds, manure, inorganic fertilizer, agro-chemicals and Integrated Pest Management (IPM)[29]). Most farmers have once used improved seeds (73%) or inorganic fertilizer (58%) in maize production, while fewer farmers have used manure (29%), agro-chemicals (22%) or IPM (4%). Farmers are quite aware about the existence of these modern inputs, as farmers that use these modern inputs are using them for more than 8 years, and farmers have heard about these technologies for over 13 years.

Table 8-9: Application, information sources and knowledge of improved inputs

	Improved seeds		**Manure**		**Inorganic Fertilizer**		**Agro-chemical**		**IPM**	
	Mean	s.d.	Mean	s.d.	Mean	s.d.	Mean	s.d.	Mean	s.d.
Farmers once used this input in maize production (%)	73	44	29	45	58	49	22	41	4.1	20
Years since farmers are using this input (number)	8.3	7.1	15	11	11	9.3	8.8	7.6	8.6	6.5
Years since farmers first heard about this input (number)	13	9.2	22	13	16	11	13	9.4	13	8.5
Farmers first heard about this input from										
Neighbors (%)	29	45	19	39	28	45	22	41	20	40
Relatives (%)	17	38	62	49	26	44	25	43	26	44
Extension agents (%)	37	48	14	35	31	46	37	48	43	50
Traders (%)	2.6	16	0.2	4.2	2.6	16	4.2	20	0	0
Radio (%)	6.8	25	0.9	9.4	6.1	24	4.0	20	11	32

[29] Integrated Pest Management (IPM) is an integrated crop management technique where a combination of biological and chemical techniques are applied to minimize the impact of pests.

Input company (%)	4.6	21	0.4	5.9	4.9	22	6.1	24	0	0
Other source (%)	2.7	16	3.2	18	2.5	16	2.6	16	0	0
For advice on this input, farmers consult										
Neighbors (%)	22	41	21	41	22	42	16	37	21	41
Relatives (%)	7.9	27	39	49	12	32	12	33	23	42
Extension agents (%)	60	49	36	48	56	50	60	49	49	50
Traders (%)	1.8	13	0.2	4.2	1.9	14	2.6	16	0	0
Radio (%)	2.3	15	0.4	5.9	2.2	15	1.4	12	6.3	24
Input company (%)	4.3	20	1.2	11	3.8	19	6.6	25	1.3	11
Other source (%)	1.8	13	2.7	16	1.4	12	1.7	13	0	0
Farmers were trained on the application of this input (%)	49	50	32	47	50	50	50	50	60	49
Farmers used the input in last year's maize production (%)	90	29	67	47	95	22	85	36	78	42
Farmers state to know the recommended rate of this input (%)	72	45			72	45	66	47		

Note: 'Mean' is the mean, 's.d.' is the standard deviation

For each input, Table 8-9 shows which information source farmers used the first time to get information about the input, and which source they consult to get advice on the input. For all inputs but manure, most farmers made use of extension agents to obtain information about the modern inputs for the first time (ranging from 31% to 43%). However, a large share of famers also receive information about these modern inputs from neighbors and relatives, indicating the importance of social learning when technologies are new. Other sources of information are less often used. A similar picture arises on the information sources that farmers consult when applying the modern inputs. The large majority of farmers consults extension agents for advice, and to a lesser extent, they consult their neighbors and relatives. However, even though farmers that once used modern technologies, they do not appear to have received specific training on how to apply the modern input. For each of the different inputs, about half of the farmers was not trained on how to apply the modern input.

Finally, a large majority of the farmers that ever used the modern inputs listed in Table 8-9 have used the inputs for maize production in the last production season. 90% of these farmers have used improved inputs, 95% of the farmer have used inorganic fertilizer and 85% used agro-chemicals. Hence, there seems to be some persistence in input usage. Moreover, about 70% of the farmers that used the modern input in last year's production state that they know the recommended rate of this input.

9 Economics of maize production

9.1 Expenditure on modern inputs

We asked farmers about their expenditure on different agricultural inputs applied in maize production. Table 9-1 shows the summary statistics for all households that grew maize during the long rainy season on their (own) maize plots. The expenditure cost includes both the cost of purchasing the input as well as the cost of transport of collecting the input.[30] On average, households in Tanzania spend 94 USD per hectare of maize production on modern inputs, and mainly spend their input purchases on inorganic fertilizer (56 USD/ha) and improved seeds (34 USD/ha). Male-headed households spend on average 9 USD per hectare more on input acquisition than female-headed households do; but this difference is not statistically significant from zero.

Table 9-1: Household level expenditure on modern inputs in maize farming

Input expenditure (USD/ha)	Male head		Female head		All			
	n=1,589		n=296		n=1,885			
	Mean	s.d.	Mean	s.d.	Mean	s.d.	min	max
Improved maize seeds	33	34	27	33	32	34	0	284
Organic Fertilizer - total	2	11	2	11	2	11	0	171
Inorganic Fertilizer - total	59	73	55	76	58	74	0	560
P fertilizer	24	41	18	35	23	40	0	229
N fertilizer	33	46	35	48	33	47	0	514
NPK fertilizer	0	5	0	2	0	5	0	116
Agro Chemicals - total	2	7	1	5	2	6	0	65
Insecticide	1	4	1	3	1	4	0	65
Fungicide	0.0	1	0.0	0	0.0	1	0	22
Herbicide	1	4	1	4	1	4	0	45
Total maize inputs	98	92	89	95	96	93	0	648

Note: 'n' is the number of observation, 's.d.' is the standard deviation

In appendix 14.4.1, we compare expenditure on improved seeds, inorganic fertilizer (all types combined), agro-chemicals (all types combined), and total inputs between regions, farm size quintals and asset value quintals. Farmers in the south spend significantly more on inputs, mostly because of substantial higher expenditure on improved seeds. There does not seem to be a clear pattern between wealth and expenditure on (any type of) modern input in maize production. Appendix 14.4.1 also reports some qualitative data on how and where farmers purchased modern inputs. Three out of four farmers bought their inputs from local agro-dealers, and the large majority of the maize farmers used cash out of the pocket to finance inputs. Only 2% of the farmers finance input purchase on credit that they had to pay back later.

9.2 Cost of (hired) labor

There are also labor costs to maize production. We consider the explicit cost of hired labor in maize production (and hence abstract from the implicit cost of family labor in maize production – which is the dominant source of labor in Tanzania according to Table 8-4). To calculate the cost in USD/ha we use the wage data collected at FO level during the community questionnaire (however,

[30] Some farmers reported to have used agricultural inputs from the last year's stock of inputs. For these households, the expenditure will report a zero value on the agricultural input(s) (i.e. instead of assuming a missing value) because they applied the input(s) but did not purchase it.

to minimize the impact of outliers, we use the district median value). On average, Table 9-2 shows that FtMA farmers spend 32 USD per hectare of maize on hired labor. Female-headed households spend on average 10 USD per hectare more on labor than male-headed households do. Further disaggregated analysis is presented in Appendix 14.4.2.

Table 9-2: Household level expenditure on hired labor in maize farming

Labor cost (USD/ha)	Male head		Female head		All	
	n=1,589		n=296		n=1,885	
	Mean	s.d.	Mean	s.d.	Mean	s.d.
Maize preparation	7	14	10	16	8	14
Application of fertilizer and weeding	14	24	19	31	15	25
Harvesting	6	11	8	12	7	11
Post-Harvest handling	2	4	3	6	2	4
Total	31	45	41	52	32	47

Note: 'n' is the number of observation, 's.d.' is the standard deviation, 'min' is the minimum, 'max' is the maximum

9.3 Maize marketing

Farmers in the survey were asked about their marketing behavior of the maize that was harvested during the last production season. In this section, we report the sales quantity and values, while appendix 14.4.3 reports more detailed information on why household sold, to who, etc. 1,220 households indicate that they have sold (part of the maize) that was harvested during the long rainy season of 2015 – 2016. This amounts to 67% of the farmers that harvested maize at the time of the interview and 65% of all maize growing households. Most of these farmers sold maize because they needed extra cash (61%) or they had to pay off debts for school fees or health services (17%) (see Appendix 14.4.3).

Table 9-3 shows the characteristics of the maize sales of those households that cultivated maize in the long rainy season and sold part of their harvest. Maize selling households reported to have on average one maize transaction. The maize selling households on average sold 1.5 ton of maize per hectare of land cultivated, which is on average 57% of the 2.6 ton per hectare of maize that this group of farmers produces (results not reported). The price they received for the maize was on average 192 USD/ton or 416 TSH/kg. The total value of maize sales then amounts to 276 USD per hectare of maize cultivated. Male headed household tend to have a larger value of maize sales, but this difference is not statistically significant (see appendix 14.4.3). More disaggregated analysis is presented in appendix 14.4.3, but it is interesting to note that maize sales value increases with farm size and asset value, but in a non-linear pattern.

Table 9-3: Maize marketing characteristics

Maize sales	N	Mean	s.d.	Median	Min	Max
		all households				
Household sold maize (%)	1,885	65	48	100	0	100

Number of maize transactions	1,220	1.0	0.1	1	1	3
Total quantity of maize sold (ton/ha)	1,220	1.5	1.2	1.2	0.06	7.1
Price received for maize sold (USD/ton)	1,220	192	79	184	18	787
Value of total quantity of maize sold (USD)	1,220	554	845	251	14	6,631
Value of total quantity of maize sold (USD/ha)	1,220	276	246	205	10	1,430
	Male head (N=1,034)			*Female head (N=186)*		
	Mean	s.d.	Median	Mean	s.d.	Median
Household sold maize (%)	65	48	100	63	48	100
Number of maize transactions	1.0	0.1	1	1.0	0.1	1
Total quantity of maize sold (ton/ha)	1.5	1.3	1.2	1.4	1.1	1.2
Price received for maize sold (TSH/kg)	192	79	184	187	80	181
Value of total quantity of maize sold (USD)	569	852	264	472	804	207
Value of total quantity of maize sold (USD/ha)	277	244	205	268	258	182

Note: 'n' is the number of observation, 's.d.' is the standard deviation,'min' is minimum, 'max' is maximum

9.4 Maize income

Table 9-4 shows the net income in maize farming, calculated respectively as the gross income from maize sales (section 9.3) minus the cost of modern inputs (section 9.1) and hired labor (section 9.2). Taking into account all non-labor and hired labor input costs, the net income from maize sales is on average 137 USD per hectare. Households headed by females tend to have lower net incomes, but this difference is only weakly significant. The net income from maize production is higher in the north and center of Tanzania, but the difference is not statistically significant. Finally, households that fall in the higher wealth quintals tend to have larger net incomes from maize sales.

Table 9-4: Net income in maize farming disaggregated over gender, region, and wealth indicator

Maize net income (USD/ha)							
	N	Mean	s.d.	Median	Min	Max	Sign. Diff.?
Whole sample	1,220	137	234	85	-311	1,235	n.a.
Per sex of household head							
Male	1,034	142	236	85	-311	1,235	
Female	186	112	223	70	-308	903	*
Per region							
South	630	122	253	66	-311	1,235	
N&C	590	154	212	100	-293	1,127	
Per farm size quintal							
Q1	296	106	222	77	-310	1,048	
Q2	220	102	233	64	-289	1,227	
Q3	159	123	205	90	-290	891	
Q4	257	154	242	85	-311	1,096	**
Q5	288	189	247	115	-302	1,235	***
Per asset value quintal							
Q1	233	130	217	85	-310	1,008	
Q2	238	141	222	85	-286	959	

Q3	236	133	237	69	-308	1,235
Q4	240	118	231	82	-287	1,096
Q5	273	161	258	92	-311	1,127

Note: 'n' is the number of observation, 's.d.' is the standard deviation, 'min' is the minimum, 'max' is the maximum

Figure 9-1 shows the histogram of the net maize income. For 28% of the households that sell maize, income from maize sales is equal or below zero, indicating that the sales of maize was not profitable enough to cover the input expenses (but this of course does not take into account the monetary value of maize for consumption). It further shows that there is quite some heterogeneity in the (positive) incomes from maize sales, going to almost 1,250 USD per hectare.

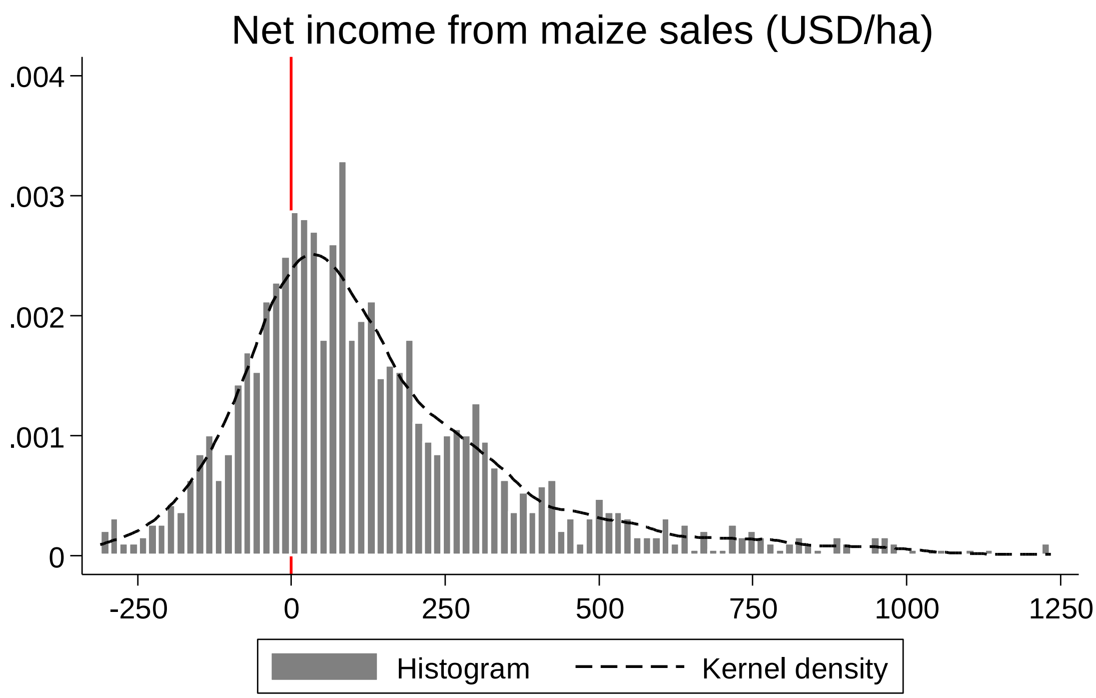


Figure 9-1: Histogram of net income from maize sales

10 Household livelihood strategies

10.1 Employment

Table 10-1 reports the employment status of the household head, where we distinguish between main and secondary occupation. 91% of the household heads is active in any type of wage, self or unpaid employment. The large majority of these household heads is engaged in self-employment (88%), while less than 3% of the households are active in either wage employment or unpaid family labor. 94% of the household heads that are active in any type of employment, is employed in the agricultural sector. Similarly, 93% of the self-employed household heads are active in agriculture. The majority of the household heads does not have a secondary occupation, as only 10% have a secondary wage, self or unpaid employment. 86% of the household head responded to be occupied with unpaid household work or not looking for a secondary job.

Table 10-1: Employment status of the household head

Characteristics of household head	N	Mean	s.d.	N	Mean	s.d.
	Main occupation			**Secondary occupation**		
Head is active in any wage, self, or unpaid employment (%)	1,933	91	28	1,933	10	30
Occupation of the household head is						
Wage employment (%)	1,933	3.0	17	1,933	2.2	15
Self-employment (%)	1,933	88	32	1,933	8.1	27
Unpaid family labor (%)	1,933	2.3	15	1,933	0.05	2.3
Not active (%)	1,933	7.5	26	1,933	86	35
Other employment (%)	1,933	1.2	11	1,933	1.6	13
Sector of occupation of the household head is						
Agriculture (%)	1,782	94	24	229	18	39
Manufacturing (%)	1,782	0.3	5.3	229	0.4	6.6
Construction (%)	1,782	0.7	8.5	229	5.7	23
Wholesale or trade (%)	1,782	0.2	4.7	229	14	34
Transport (%)	1,782	0.2	4.1	229	8.7	28
Services (%)	1,782	4.4	21	229	50	50
Head is active in any wage, self, or unpaid employment in agriculture (%)	1,782	94	25	229	17	38
Head is active in self-employment in agricultural sector (%)	1,782	93	25	229	16	37

Note: 'n' is the number of observation, 's.d.' is the standard deviation

The labor supply and income of the household head from their primary and secondary occupation are reported in Table 10-2. Household heads on average worked 7 months per year, 3 weeks per month and 41 hours a week for their main occupation. Those household heads with a secondary occupation, work on average for 9 months a year, 4 weeks a month and 42 hours a week on the second occupation. Household heads with wage income reported to receive in total between 1.7 and 2.5 thousand USD during the last 12 months. For those with a wage job as secondary occupation, the income derived is between 1.6 and 1.8 thousand USD.

Table 10-2: Labor input and income of household head

	N	Mean	s.d.	N	Mean	s.d.
	Main occupation			**Secondary occupation**		
Months worked by household head (number)*	1,619	7.2	2.5	229	8.9	3.6
Weeks worked by household head (number)	1,618	3.4	0.8	229	3.5	0.9
Hours worked by household head (number)	1,619	41	26	229	42	29
Total income from wage employment - self reported (USD)	58	2,455	3,656	42	1,826	1,434
Total income from wage employment - calculated based on wage (USD)**	80	1,730	2,119	42	1,646	1,287

*Note: 'n' is the number of observation, 's.d.' is the standard deviation. *166 observations have no information on time spent because they were recoded as 'dependent on agriculture'. ** Income calculated as product of daily wage and days worked.*

Finally, household were also inquired about income from non-farm enterprises or non-labor income sources. 25% of the households in the baseline survey have anyone within the household that has operated a non-farm labor enterprise in the last 12 months. Appendix 14.5.1 gives a more detailed description of the (largest) non-farm enterprise operated by the household. Table 10-3 shows that the sample average income from non-farm enterprises is 891 USD. Table 10-3 also gives an overview of the access to and income from non-labor activities. In general, 20% of the households have access to any type of non-labor income sources, which is mainly income from rental activities or remittances. On average, the households in the baseline survey earned 71 USD from non-labor income sources.

Table 10-3: Income from non-farm labor enterprises and non-labor activities

Income received from	Household received income (%) (N=1,933)		Level of income (USD)				
			Whole sample (N=1,933)		Sub sample		
	Mean	s.d.	Mean	s.d.	N	Mean	s.d.
Non-farm enterprises	25	43	891	3,758	484	3,557	6,854
Non-labor income sources							
land or property rental	7	26	27	204	138	380	672
equipment or animal rental	5	22	13	103	99	246	388
remittances	8	27	16	91	152	197	262
national security or pension	2	13	9	99	33	553	535
social assistance	1	8	0	7	12	60	70
inheritance	1	12	3	43	27	203	309
other income source	1	9	3	54	15	436	456
Total non-labor income	20	40	71	309	383	360	615

Note: 'n' is the number of observation, 's.d.' is the standard deviation. Sub sample refers to the group of households that was active in the specified income activity.

10.2 Income from other crops

While detailed plot level data was collected for maize production, we also collected household level data on the production of other crops. We restrict the presentation here to the 5 most important crops – i.e. beans, sunflower, pigeon peas, groundnut, and coffee – which in total account for 84% of the observations at crop level. Appendix 14.3.4 provides a detailed overview of input usage, expenditures, harvest and marketing outcomes for these crops. Table 10-4 reports the total net income from selling these 5 crops (i.e. by reducing income from sales with expenditures on modern inputs and hired labor) at the household level. The first row of Table 10-4 shows that the average net income from the production of the 5 most important crops other than maize is 146 USD per household and 29 USD per capita. Male headed households significantly earn more from other crops. There is no significant geographical difference in the net income per household. The net income seems to be strongly related with both farm size and asset value, especially in the higher wealth quintals.

Table 10-4: Net income of 5 most popular crops other than maize disaggregated over gender, region, farm size and asset value

Other crops	Net income from other crops (USD)			Per capita income from other crops (USD/person)		
	N	mean	s.d.	mean	s.d.	sign diff
Whole sample	1,933	146	419	29	89	n.a.
Per sex of household head						
Male	1,631	158	447	30	94	
Female	302	88	219	23	64	***
Per region						
South	975	134	408	28	78	
N&C	958	160	433	30	100	
Per farm size quintal						
Q1	589	80	335	21	109	
Q2	352	83	180	21	61	
Q3	238	101	269	20	57	
Q4	370	161	329	30	67	***
Q5	384	323	706	53	109	***
Per asset value quintal						
Q1	388	67	166	17	46	
Q2	390	82	207	17	46	
Q3	384	116	378	22	70	**
Q4	385	206	506	44	142	***
Q5	386	265	625	45	101	***

*Note: 'n' is the number of observation, 's.d.' is the standard deviation. 'sign. Diff.?' refers to the significant difference in mean value of the outcome specified in the one but last column between households in different regions, farm size quintals or asset value quintals. These are obtained from the regression of the outcome variable on the region dummy, farm size quintals and asset value quintals; where the first dummy is taken as reference. Q1 to Q5 refer to the first to fifth quintal, South and N&C respectively refer to south Tanzania and central and north Tanzania. The stars refer to the level of significance: *p<0.10, **p<0.05, ***p<0.01, no star: insignificant difference, n.a. means not applicable.*

10.3 Livestock ownership

Finally, the survey incurred households about their ownership and value of different type of livestock animals. Table 10-5 summarizes the livestock ownership, and value of existing stock and value of livestock (product) sales. 92% of the households declared to own at least one livestock animal of the following list: bulls, cows, steers, heifers, male or female calves, goats, sheep, pigs, chickens, rabbits, donkeys, or beehives. Almost 60% of the households owns at least one cattle animal (i.e. one of the first five animals in the livestock list) and 77% of the households owns at least on chicken. Farmers were asked, for each type of livestock animal owned, to report the value it they were to sell one unit of livestock today. Using this information, we were able to calculate the total value of livestock for each household, which is on average 1,127 USD. 15% of the households sold any type of livestock or livestock related product (e.g. milk, yoghurt, eggs, etc.) and the total value of these livestock (products) sales is 22 USD.

Table 10-5: Livestock ownership and value

Livestock (N=1,933)	mean	s.d.	p50	min	max
Household owns any type of livestock (%)	92	27	100	0	100
Household owns at least one … (%)					
Bull	40	49	0	0	100
Cow	47	50	0	0	100
Cattle	58	49	100	0	100
Goat	49	50	0	0	100
Pig	23	42	0	0	100
Chicken	77	42	100	0	100
Total value of livestock owned (USD)	1,127	1,664	570	0	12,756
Household sold any livestock product (%)	15	35	0	0	100
Income from livestock sales (USD)	22	87	0	0	874

Note: 'n' is the number of observation, 's.d.' is the standard deviation, 'min' is minimum, 'max' is maximum

10.4 Access to financial services

Table 10-6 looks at the financial means of the surveyed households. On average, 84% of the households in the sample has access to mobile money on their mobile phone. A lower share of household (35%) in the survey sample has a bank account. Male headed households appear to be slightly more likely to have a mobile money or bank account, but this effect is not statistically significant. On the contrary, the use of mobile money or bank account is significantly higher in the central and northern zones of Tanzania. If we disaggregate the data per farm size or asset value quintal, we observe an increasing percentage of households with access to mobile money or a bank account with higher asset value or farm size, but increases are significantly only for the higher farm size or asset value quintals.[31]

Table 10-6: Access to financial services, overall and disaggregated over gender, region, farm size and asset value

Household has… (%)		mobile phone money account		bank account		private insurance		taken loan		
	N	Mean	s.d.	Mean	s.d.	Mean	s.d.	Mean	s.d.	sign diff
Whole sample	1,933	84	36	35	48	33	47	15	36	n.a.
Per sex of household head										
Male	1,631	85	36	35	48	33	47	14	35	
Female	302	82	38	32	47	33	47	20	40	**
Per region										
South	975	81	39	30	46	33	47	13	34	
N&C	958	88	33	40	49	33	47	17	38	

[31] We also asked how households use mobile money, but the data is not reported in Table 10-6. The large majority of the households use mobile money to both send and receive money (86%), and to a lesser extent for buying airtime (37%) or saving money (23%). 60% of the households uses mobile money services on their mobile phone at least every month (or more frequently), and 23% uses it weekly or daily.

Per farm size quintal									
Q1	595	79	41	25	43	30	46	16	36
Q2	346	81	39	32	47	29	46	14	35
Q3	238	84	36	35	48	39	49	14	35
Q4	370	88	33	36	48	35	48	12	33
Q5	384	93	26	52	50	34	47	18	39
Per asset value quintal									
Q1	388	75	43	25	44	26	44	16	36
Q2	390	83	38	31	46	32	47	13	34
Q3	384	84	37	32	47	36	48	16	37
Q4	385	85	36	35	48	29	46	18	38
Q5	386	95	21	52	50	42	49	13	34

Note: 'n' is the number of observation, 's.d.' is the standard deviation. 'sign. Diff.?' refers to the significant difference in mean value of the outcome specified in the one but last column between households in different regions, farm size quintals or asset value quintals. Q1 to Q5 represent the first to fifth quantile of the farm size or asset value distribution.

One out of three households has a private insurance, and this number is the same across gender or region. This private insurance is mainly taken for health insurance (95%) or car or motorcycle insurance (3%) (Appendix 14.5.2). There is no clear relationship between uptake of insurance and wealth.

Finally, 15% of the households in the sample took up a loan. Interestingly, female farmers are (significantly) more likely to take up a loan. There is a small difference between regions, but that difference is not statistically significant. Similar to insurance, there is not a straightforward relationship between the percentage of households that took up a loan and any of the wealth indicators. We asked household that did not take up a loan to specify why they did not, and the results are presented in Figure 10-1. Almost half of the households indicated that they did not need a loan (45%). Other reasons for not taking a loan are too high interest rates (13%), no-one available in the village to give out loans (11%), household being afraid not able to pay back loan (11%) or other for other reasons (11%). Appendix 14.5.2 reports the result of a small experiment to understand whether and how households are credit constrained by asking household heads whether the household would be able to raise an additional amount of 50,000 TSH a week before and after harvest, and how they would do so.

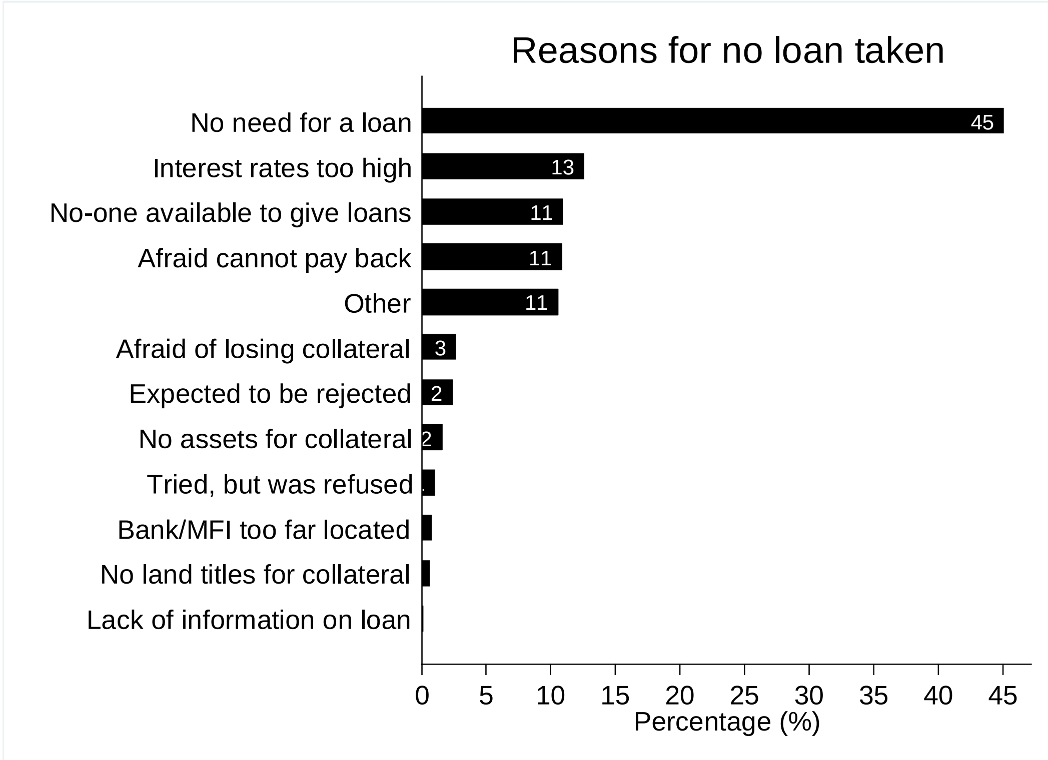


Figure 10-1: Reasons why farmers do not take a loan

For those households (294 in total) that took out a loan in the last production season, we asked more details on the source and type of loan. The results are reported in Table 10-7. 98% of the households took out one loan, and only 6 household took out a second loan. The value of the loan taken is on average 524 USD, and ranges from 14 to 5,520 USD. The interest rate on the loan is on average 12%, but can be as high as 100%. The average duration of the loan is 9 months, but there is a wide variation in the data. 66% of the loans required some type of guarantee for the amount borrowed, and the widely used guarantees are savings (30%), land (27%), or a personal guarantee (27%). Almost no loan required an upfront payment. The total value of the loan (including interest rate) was on average 611 USD.

Table 10-7: Characteristics of loans taken by households

Characteristics of the loan taken (N=300)	Mean	St. Dev.	Median	Min	Max
Value of the amount borrowed (USD)	524	940	184	14	5,520
Interest rate on loan (%)	12	13	10	0	100
Duration of the loan (months)	9	11	6	1	90
Loan required guarantee (%)	66	47	100	0	100
Loan required upfront payment (%)	0	0	0	0	1
Total value of the loan (1,000 TSH)	611	1,115	217	14	6,274

Note: 'n' is the number of observation, 's.d.' is the standard deviation, 'min' is minimum, 'max' is maximum

The graphs in Figure 10-2 provide more information from who and for which reason households borrowed money. The graph on the left shows the reasons for which households took out a loan.

Most of the loans were taken for either buying agricultural inputs (35%) or financing agricultural investments (24%). Other common reasons for loans are paying for school fees (19%), subsistence needs (16%), and non-agricultural investments (15%). The right graph displays the sources from which households in our sample took out a loan. The most commonly used sources of loans are self-help groups (30%), micro-finance institutions (20%), cooperatives or farm organizations (18%) or commercial banks (11%).

Figure 10-2: Reasons for taking a loan and source of loan

11 Beliefs and preferences

This section briefly discusses some of the measurements elicited with respect to the beliefs of the sample of surveyed farmers. Several reasons make it important to understand the beliefs and preferences of farmers, as it provides a guide for understanding the actions taken by farmers. For example, if farmers believe that the increase in expected yield that would result from adopting a new technology (or input) is small, then this would explain why they might be unwilling to adopt the new technology. Similarly, even if the farmers believe that the increase in expected yield would be large if they changed their approach from their existing practice to using some new technology, their trust in the person selling the inputs (e.g. seeds) and the risk of buying fake seeds, might retain farmers to adopt the new technology due to the risk of being cheated.

More generally, the context under consideration, namely the reduction of risks faced by smallholder farmers is one in which beliefs play a particularly important role. Risks are present when there is uncertainty. As discussed above, these smallholder farmers face an array of risks, including weather uncertainty, price uncertainty, buyer uncertainty as well as uncertainties regarding whether they can trust the other individuals that they need to rely (e.g. the seed seller) on in order to successfully produce and sell their crops.

Lastly, we consider how much the farmers trust other individuals who are important for the successful production and sale of their crops. This is extremely important for small-holder farmers as they rely so heavily on a large number of other individuals in order to complete the cycle of acquiring inputs, and then growing and selling their crops. Furthermore, there are potentially large complementarities and benefits of scale to grouping together as a collective and reducing the costs of things like storage, transport and negotiating deals.

The discussion on beliefs and preferences is presented in Appendix 14.6, but the key observations are the following. First, farmers are most worried about insufficient rain during planting, followed by drought. Second, 33% of the farmers expect rainfall to be normal in the next growing season, but farmers view rainfall risk as being skewed in the negative direction, with more downside risk than upside risk. Third, both the conditions of weather and level of input use affect the expected distribution of yields, but the former has a larger impact on expected probabilities. Fourth, farmers have high trust in FO leaders and other FO members, and have an intermediate degree of trust in the reliability of the fertilizer supplier, and the output buyer. However, farmers appeared to be skeptical regarding the reliability of the seed supplier, suggesting a high degree of mistrust on behalf of the farmers when it comes to the supply of new seeds.

12 Conclusion

This baseline report documents on the household and farm characteristics of maize farmers that are targeted by the FtMA – WINnERS intervention. The purpose of the baseline data is to describe the status of potential participants of the intervention, before the intervention was rolled out. The baseline data will be used later to capture how the intervention has affected maize outcomes over time (and between groups). The most important characteristics of the households interviewed are:

1. Most farmers are considered to be relatively better off compared to their counterparts in Tanzania when we look at farm size, poverty scores, and food security indicators. The farmers in the baseline survey are sampled from the list of FO members, and hence these farmers are more likely to be a bit better off than a random farmer in Tanzania.
2. Decision making in the household seems to be fairly balanced between males and females in the household. The involvement of children in household tasks is rather small, except of activities related to agriculture. Males and females also seem to have similar access to resources and the benefits generated from these resources.
3. The average farm size is 2.1 hectare and the size of land cultivated with maize is 1.8 hectare. Hence, the baseline survey farmers are highly dependent on maize cultivation.
4. Half of the farmers cultivate maize with improved seeds and use any type of inorganic fertilizer. However, very few apply modern inputs on the same plot. Moreover, while they do interact about modern inputs with extension agents and social peers, farmers have limited knowledge or have not received training on the proper application of them. Maize cultivation is partly mechanized, and especially so for the larger farms.
5. Farmers that harvested maize achieved an average yield of 2.2 kg per hectare. 67% of the farmers sold maize, because they need cash, and mostly within the village and to middlemen. The net income from maize selling for the sellers is on average 137 USD per hectare.
6. Only 15% of the farmers took out a loan in the past production season. If they did, it was mainly done to finance agricultural inputs or investments. Virtually none of the farmers has crop insurance.

PART III:

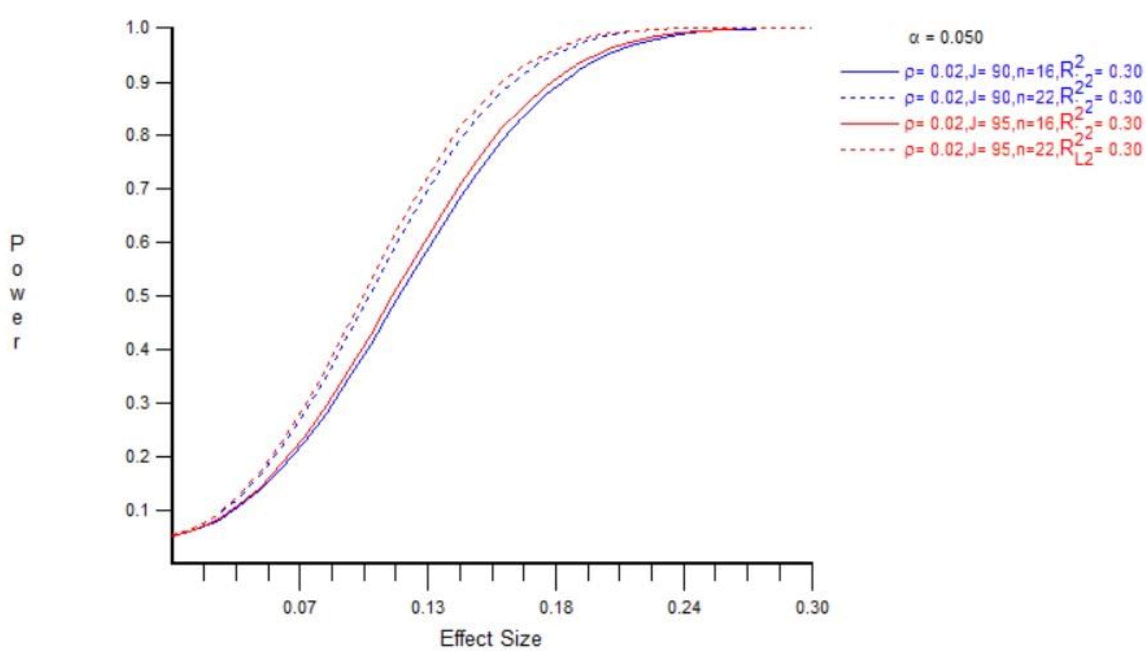
APPENDICES

13 Appendix I: further on survey design

13.1 Sample calculations

Considering the focus on agricultural productivity and using the LSMS-ISA 2012-13 data, i.e. the Tanzania National Panel Survey, for reference; the following information can be used for the power calculations:

- Primary outcome: yearly earnings from agricultural sales (maize and other crops) among maize farmers. Mean = 310,914 TZS (about 142$) and s.d. = 1,061,060.
- Intra-Cluster Correlation (ICC): ICC is estimated to be low (i.e. <0.05) and vary between 0.02 for more nuclear FOs and 0.014 for bigger FOs. Average ICC = 0.017.
- Significance level: 0.05. The standard level of significance is preferred. However, it should be noted that the research team is interested in assessing the impact on different outcomes. Thus, the significance level required might be lower - so that statistically significant treatment effects might be identified even when accounting for the multiple inference problem by calculating the Family-Wise Error Rate.
- Proportion of variance that can be explained by control variables: 0.3.
- Expected effect size: Information regarding the success of the first round of the FtMA project is still not available. Credit uptake was around 20%, but the low rate was in part due to implementation issues during the awareness campaign. Hopes for 2016 are as follows: credit uptake around 40%, farmers' earnings being doubled by the complete FtMA package (official expectations are set on an increase in income of about 400$ - the mean annual income), and earnings being increased by 5% by FtMA contracts. So the adjusted effect size could be as high as 43%, with the standardized effect size $\delta = 0.13$



13.2 FO selection

FOs are the primary unit of engagement for the FtMA. Several different types of FOs are included currently in the Alliance reflecting the diversity of organizational structure of farming organizations in Tanzania.

Eligible FOs can belong to different status types, some are large associations, some are marketing societies (AMCOS - Agricultural Marketing Cooperative Society), and some have a ROSCA structure (SACCOS - Savings and Credit Cooperative Society).

- AMCO (Agricultural Marketing Co-operative Organization): marketing societies
- SACCO (Savings and Credit Cooperative Organization): ROSCA structure
- Farmer Associations: these may be smaller non-formal associations of farmers that can participate in other larger formally registered groups
- APEX group: Several other FOs my join together under one umbrella group to participate in the Alliance

Accordingly, they are registered under different national archives: associations and AMCOS are registered under the government agency BRELA (Business Registrations and Licensing Agency), while SACCOS are registered at RITA (Registration Insolvency and Trusteeship Agency). Such heterogeneity in FO types might constitute a threat for the impact evaluation.

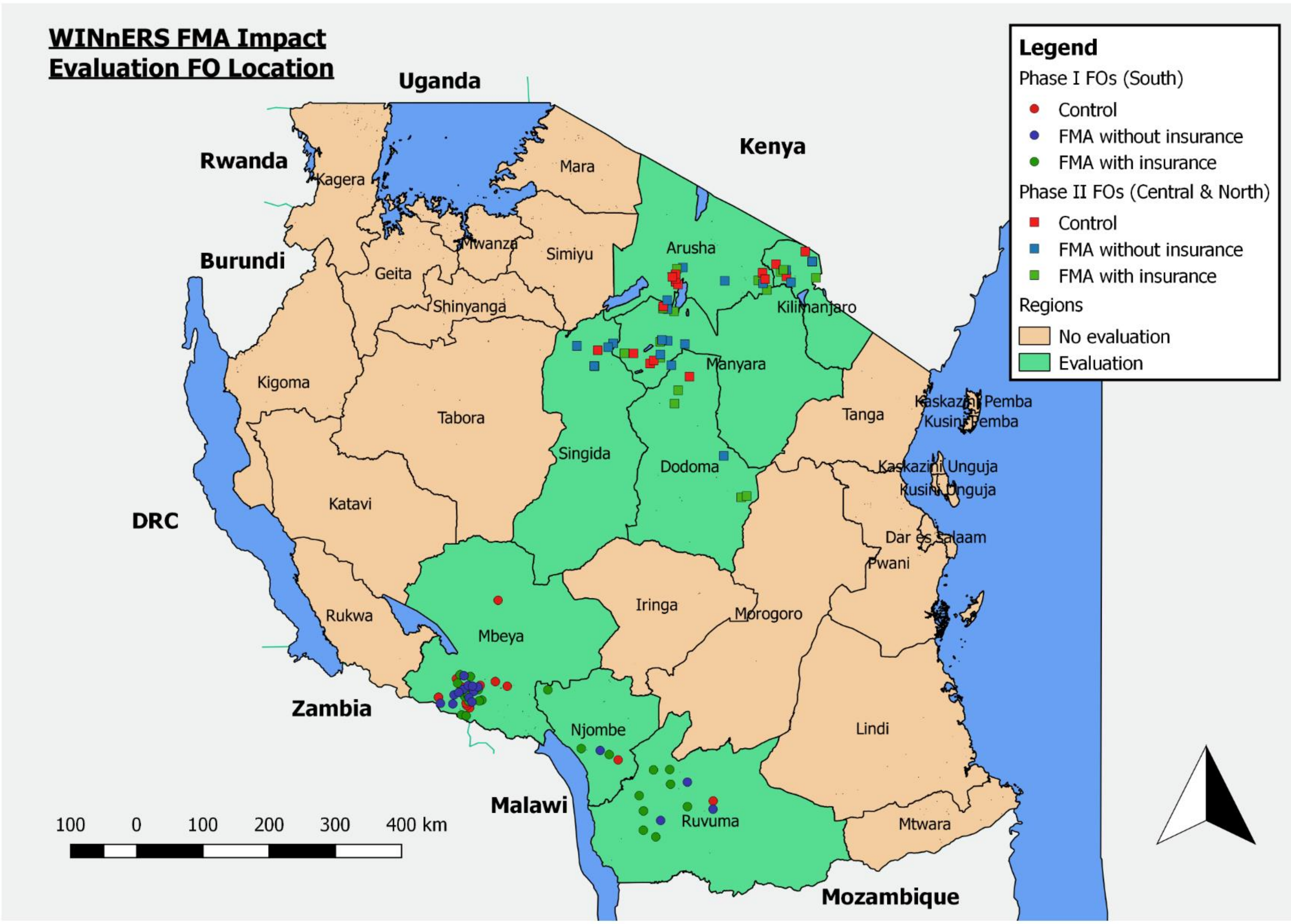
The shortlist of eligible FO was constructed by PASS as follows. First, a number of local NGOs (BRiTEN, RUDI, Norwegian Church Aid, BRAC, NAFAKA, TechnoServe, etc.) and private companies (Cheetah Development, etc.) have listed FOs from the 3 geographical zones that they deemed to be potentially eligible to receive a loan. Additionally, WFP selected FOs in which they were previously engaged (e.g. the Purchase for Progress (P4P) intervention). Then, the eligibility of FOs to receive loans is formally evaluated by the Private Agricultural Sector Support (PASS Trust) – a financial access service institution – with advice provided from the local banks. Eligible FOs need to be registered with a government authority because they need to have sufficient financial strength to receive credit from a local bank. Then, PASS assesses different criteria for eligibility, based on guidelines for financial viability and business sustainability.[32] The PASS Trust assesses FOs and helps them fulfill the eligibility criteria, it meets with them repeatedly, gives them specific instructions on how to prepare the needed documents, and sets follow-up meetings for the submission of additional documentation with final deadlines to be met. If FOs do not have a strong

[32] Specifically eligibility requires being able to submit the following documents: 1. Loan application letter; 2. Minutes of the last Annual General Meeting; 3. List of members who attended the AGM; 4. Previous production records; 5. Purchase contract from WFP; 6. Detailed costs analysis of the loan; 7. Capacity of the 20% contribution; 8. Maximum liability from cooperative society officer; 9. CV of the leader; 10. Constitution of the group; 11. Audit reports for 3 years; 12. Group registration document; 13. Bank statement for 12 months; 14. Loan history of the group; and 15. Shares, savings, and loan history of farmers.

leadership, it also helps them in capacity building by contacting local officers that could be of assistance.

After the eligible list of FOs has been established, there are several sieves that the FOs must pass through before being put forward to the bank for credit application, including compliance with WFP selection criteria, compliance with PASS selection criteria, local bank initial requirements, and formal loan application requirements (credit committee). For the 2017-2018 production season, the universe of FOs that WFP intends to work with has been established using the Scope Insight tool in conjunction with IFC. This has generated a list of 120 perspective FOs and given them ratings based on the professionalism of the groups.

13.3 Geographical location of FOs



13.4 Key outcome measures captured in the survey and research questions to be addressed

Key outcome variables that need to be collected during the survey are as follows:

- Uptake of improved technologies in maize production:
  a. Adoption of inputs (improved seeds, fertilizers, etc.)
  b. Technical agricultural knowledge
  c. Improved agricultural practices/tools
  d. Use of agricultural extension and services
- Maize level outcomes
  a. Yearly crop sales (in particular by volume)
  b. Crop yields measured in kg per hectare
  c. Post-harvest losses
  d. Labor usage/productivity
  e. Expenditure on improved maize technologies and inputs (herbicides etc.)
- Other crop outcomes (spillover effects from maize intervention)
  a. Crop diversification (variety of crops grown)
  b. Agricultural labor allocation
  c. Total agricultural income
  d. Yields
- Household level outcomes:
  a. Education
  b. Health
  c. Total household income,
  d. Non-farm labor productivity
  e. Livelihood diversification
  f. Poverty scores
  g. Food Security (FAO's Food Insecurity Experience Scale, WFP's Food Consumption Score)
- Gender-differentiated Effects: according to the IFC GAFSP gender mapping tool
  a. Decision making in agricultural production and household activities
  b. Gender balance in labor allocation over different crops
- Behavioral outcomes:
  a. Cognitive capacity (Raven matrices), time and risk preferences, risk perceptions

Using this set of key outcomes captured in the survey, there are several research questions that will be addressed.

While VCs have been identified as a sustainable approach to improve smallholders' earnings, many questions remain about their effectiveness, especially when it comes to staples. The barriers for smallholders to access established VCs are significant, the incentives for input suppliers and agro-dealers to transfer knowledge to farmers is often questionable, and the capacity of agricultural microenterprises to sustain and upgrade their positions in VCs is hugely challenging. Among farmers, the ability to pursue these opportunities can vary significantly. Challenges can be compounded by differential access to physical and human capital and restrictions that can vary depending on gender, household composition, etc., and would need to be factored in for outcomes to be inclusive. For example, exploring what underlies the patterns of gender sorting across activities in the production cycle can ensure women can enter VCs and exploit the gains from participation. Understanding these processes, as well as the impacts of VC policies, represents a key research priority and the aim of this impact evaluation.

Main research questions include:

1. Short term production and labor market outcomes:

- Does the FtMA intervention – combined effect of assured market, input package and loan – raise agricultural output, labor productivity and income in staple VCs (and reduce its volatility)?
- Does the FtMA intervention affect the level and volatility of farmers' crop portfolio choice and agricultural income?
- Does the FtMA intervention affect farmers' income diversification strategies (e.g. use improved agricultural outcomes for financing non-farm enterprises)?
- Is there heterogeneity in these outcomes introduced by gender and age (youth)?
- What is the role of (time and risk) preferences, and (cognitive or non-cognitive) abilities?
- Does the insurance element of the intervention has an additional effect on the above outcomes – controlling for the effect of the FtMA intervention (e.g. through input adoption)?
- Does the FtMA intervention improve farmers' agricultural and technological knowledge?

2. Long term intervention outcomes:

- Does the FtMA intervention contribute to intensification of agricultural production and labor productivity (level and volatility)?
- Does the FtMA intervention affect nonagricultural labor productivity and incomes?
- Does the FtMA intervention improve household income, food security, and gender empowerment, and decrease poverty?
- Does the FtMA intervention improve educational and health?
- Does the FtMA intervention improve mental capacities (by reducing stress induced by scarcity) or other (non-) cognitive skills?

3. Program participation:

- What is the uptake of different elements in the FtMA intervention?
- What determines farmers' adoption of the FtMA intervention (assured market, input package and loan) and the bundled insurance?
- What is the default rate in the FtMA program and what determines the default rate?
- How important is the functioning of the FO for success (e.g. trust between FO members)?

13.5 Questionnaire content

Agricultural questionnaire:

- Introduction
- Plot roster
- Plot level inputs only for maize plots during long rainy season
- Sales and marketing of maize long rainy season
- Short rainy season for maize
- Agricultural information and knowledge for maize production
- Crops (other than maize): input and sales
- Agricultural assets
- Livestock
- Extension
- FO and agricultural training

Household questionnaire:

- Introduction
- Household member roster
- Education
- Health
- Non-agricultural household assets
- Labor
- Family/household non-farm enterprises
- Other non-labor, income
- Credit
- Finance
- Insurance
- Recent shocks to household welfare
- Household food consumption
- Non-food expenditure
- Food security
- Housing conditions
- Decision making
- Cognitive skills (raven)
- Time, risk, trust, and reciprocity preferences
- Beliefs

FO questionnaire

- Access to basic services
- Transformation in the agricultural and maize sector
- Maize markets
- Market prices
- FO characteristics
- FO facilities
- Loans taken by FOs

14 Appendix II: further analysis of baseline data

14.1 Description of the farmers in the sample

14.1.1 Housing conditions

Table 14-1 describes the housing conditions for the households in the survey sample. 96% of all households lives in a house that is made of any type of brick material. Almost all houses (97%) have an iron roof, and a majority (68%) has a non-earth floor. 28% of the households is connected to the electric grid but only 18% of the households have no other source for cooking than firewood. The next panels of Table 14-1 compare the housing condition between gender, region, and wealth quintals. For the last three housing variables, the average number is significant larger in central and north Tanzania, reflecting the general pattern that the south of Tanzania is poorer than the rest of the country. With respect to the relationship between housing and wealth, we only observe that connectivity to electric grid and ownership of lantern significantly increases with increasing farm size and asset value quintal.

Table 14-1: Housing conditions

Housing		House is made of (any type of) brick (%)		House has non-earth floor (%)		House has iron roof (%)		Household cooks with other source than firewood (%)		Household is connected to electricity grid (%)		Household has lantern (%)	
	N	Mean	s.d.	Mean	s.d.	Mean	s.d.	Mean	s.d.	Mean	s.d.	Mean	s.d.
Whole sample	1,933	96	19	68	47	97	16	18	39	28	45	44	50
Per gender of household head													
Male	1,631	96	19	69	46	97	16	17	38	27	45	44	50
Female	302	98	15	67	47	98	15	23	42	30	46	43	50
Per region													
South	975	99	7.1	65	48	97	17	14	35	14	35	39	49
N&C	928	93	25	72	45	98	15	23	42	42	49	49	50
Per farm size quintal													
Q1	589	95	21	61	49	97	18	15	35	24	43	38	49
Q2	352	95	21	65	48	97	17	16	37	26	44	49	50
Q3	238	97	18	67	47	96	20	19	39	29	45	43	50
Q4	370	97	18	73	44	99	10	16	37	26	44	44	50
Q5	384	99	11	79	41	99	11	27	45	35	48	49	50
Per asset value quintal													
Q1	388	97	17	57	50	97	17	18	38	24	43	34	47
Q2	390	95	21	66	47	96	20	18	39	27	44	41	49
Q3	384	96	19	66	47	97	17	15	36	28	45	46	50
Q4	385	97	17	72	45	98	14	17	37	28	45	44	50
Q5	386	97	18	80	40	99	8.8	23	42	32	47	56	50

Notes: 'N' is the number of observations; 's.d.' is the standard deviation Q1 to Q5 represent the first to fifth quantile of the farm size or asset value distribution.

Next, Table 14-2 summarizes the ownership of non-agricultural assets by the households in the survey. The first two columns show the percentage (mean value and standard deviation) of households that at least owns one of the assets specified in each row. The last four columns show the descriptive statistics for the number of assets owned for those household that own at least one of the specified asset. Almost all households own (at least) one house. 94% of the households owns at least one mobile phone, and these households on average have two mobile phones. Other assets often owned by households are beds and tables, mosquito nets, radio's, and bicycles.

Table 14-2: Asset ownership of non-agricultural assets

Non-Agricultural assets	Households that have at least one (%)		Number of assets owned (number)			
	mean	s.d.	Mean	s.d.	Min	Max
House(s)	99	12	1	1	1	7
TVs	31	46	1	1	1	8
Mobile Telephones	94	24	2	1	1	11
Bicycles	62	49	1	1	1	16
Motorbikes	27	45	1	1	1	9
Car	6	24	2	2	1	9
Refrigerators	6	24	1	1	1	8
Kerosene stoves or coocker	10	30	1	1	1	9
Electric Stoves or coocker	4	19	2	2	1	8
Sewing machine	9	28	1	1	1	9
Books (not school books)	47	50	5	9	1	100
Beds	98	12	3	2	1	54
Mosquito nets	96	19	4	3	1	94
Satellite dish	22	41	1	1	1	8
Solar panel	33	47	1	4	1	100
Radio or radio-cassette player	80	40	1	1	1	8
Tables	93	25	2	1	1	12

Note: 's.d.' is the standard deviation; 'min' is the minimum and 'max' is the maximum

14.1.2 Household shock and food security indicators

Households in the survey sample were asked whether and which types of shocks the household experienced during the last 12 months. Table 7-3 gives an overview. 55% of the households reported that they experienced at least one shock during the last 12 months. The following five shocks were reported by the households in the survey sample to occur most frequently: livestock died or were stolen (24%), the death of a household member (22%), rise in agricultural input prices (20%), large fall in crop prices (19%), and large rise in food price (18%). There is indication that households in south of Tanzania and central and north experienced differential shocks, e.g. the south of Tanzania experienced less food price increases, but the differences are not very large.

Table 14-3: Recent shocks to the household

Region	Whole sample (N=1,933)	South TZ (N=975)	Central and North TZ (N=958)

Recent shocks	Mean	s.d.	Mean	s.d.	Mean	s.d.	sign. Diff
At least one shock occurred to the household last year	55	50	54	50	56	50	
Livestock died or were stolen	24	43	20	40	27	44	
Household business failure, non-agricultural	4.1	20	3.4	18	4.9	22	
Loss of salaried employment or non-payment of salary	0.7	8.2	0.6	7.8	0.7	8.5	
Large fall in sale prices for crops	19	39	20	40	18	39	
Large rise in price of food	18	39	14	34	23	42	***
Large rise in agricultural input prices	20	40	20	40	19	40	
Loss of land	0.7	8.2	0.2	4.5	1.1	11	***
Chronic/severe illness or accident of household member	6.1	24	4.5	21	7.7	27	***
Death of a member of household	5.7	23	6.2	24	5.2	22	
Death of other family member	22	41	18	38	25	44	***
Break-up of the household	2.5	16	2.4	15	2.6	16	
Hijacking/Robbery/burglary/assault	1.4	12	1.6	13	1.1	11	
Dwelling damaged, destroyed	1.0	10	1.1	11	0.9	9.7	

*Note: 'n' is the number of observation, 's.d.' is the standard deviation. 'sign. Diff.?' refers to the significant difference in mean value of the outcome specified in each row between households in different regions. These are obtained from the regression of the outcome variable on the region dummy, where the first dummy is taken as reference. South and N&C respectively refer to south Tanzania and central and north Tanzania. The stars refer to the level of significance: *p<0.10, **p<0.05, ***p<0.01, no star: insignificant difference.*

In Table 14-4, we compare the FIES food security indicators between gender, regions, farm size, and agricultural asset value. There are no large differences between male and female-headed households, but for some indicators (FIES 2 and FIES 3) there seems to be a regional difference. For the two wealth indicators, we find that the percentage of households within the quantile that faced a food security issue in general declines with higher quantiles (i.e. households with more farm size of assets), but the pattern is certainly not linear.

Table 14-4: Food security issues disaggregated over regions, farm size and asset value

Share (%) of households that faced shock		FIES 1	FIES 2	FIES 3	FIES 4	FIES 5	FIES 6	FIES 7	FIES 8	FIES 9	FIES 10
	N	Mean	s.d.	Mean	s.d.	Mean	s.d.	Mean	s.d.	Mean	s.d.
Whole sample	1,593	27	53	50	22	13	28	9	11	7	15
Per gender of household head											
Male	1,340	27	53	50	22	13	27	9	11	7	15
Female	253	25	53	48	21	13	30	9	11	9	15
Per region											
South	975	99	7.1	65	48	97	17	14	35	14	35
N&C	928	93	25	72	45	98	15	23	42	23	42
Per farm size quintal											
Q1	455	26	55	49	22	14	27	8	11	7	15
Q2	280	28	56	55	26	16	30	11	13	10	18
Q3	306	25	52	51	22	12	28	8	10	7	14
Q4	257	30	53	49	21	11	30	8	10	7	14
Q5	295	26	46	44	21	13	24	9	10	6	15

Per asset value quintal											
Q1	332	26	52	49	25	15	28	11	11	9	19
Q2	314	23	56	49	23	14	30	9	11	8	14
Q3	310	26	60	58	25	14	33	10	13	7	16
Q4	319	29	49	47	20	11	24	8	9	5	11
Q5	318	30	47	45	19	12	25	8	9	7	14

Notes: 'N' is the number of observations. Q1 to Q5 represent the first to fifth quantile of the farm size or asset value distribution. FIES 1 = Worry you would not have enough food to eat? FIES 2 = Eat unhealthy and not-nutritious food? FIES 3=Eat only a few kinds of foods? FIES 4=Eat less than you thought you should? FIES 5=Skip a meal? FIES 6=Ran out of food of any kind? FIES 7=Go without eating for a whole day? FIES 8=Be hungry but did not eat? FIES 9 = Restrict consumption by adults for small children to eat? FIES 10=Borrow food, or rely on help from a friend or relative?

14.1.3 Decision making

We present here the detailed frequency tables of the household decision-making section with respect to who in the household performs certain tasks within the household, who has access to resources and access their benefits, and who makes decisions in the household. Table 14-5 shows who in the household (adults) performs the task specified. Table 14-6 gives an overview of the degree of involvement of children in these household tasks. Table 14-7 shows who in the household has access to resources in the household. Table 14-8 shows children's (degree of) access to this list of resources. Table 14-9 presents who in the household makes decisions about (the benefits of) these resources.

Table 14-5: Detailed table of gender division of tasks in family's daily life

Share (%) of activities performed…	**Who in the household performs the following activities?**						
	All by F	Mainly by F	equally by M&F	Mainly by M	All by M	Hired labor	NA
Land preparation	2	6	60	8	4	20	0
Weeding	3	6	59	6	3	23	1
Chemical spray	2	4	23	31	10	23	7
Fertilizing	3	7	58	8	4	17	2
Harvesting	2	5	62	4	3	24	0
Post harvesting activities	2	7	55	8	5	16	7
Maize Transportation to collecting point	2	5	34	15	3	14	27
Purchasing agricultural inputs	6	8	33	40	11	1	1
Hiring labor	5	6	37	25	7	1	19
Selling of maize	5	9	45	27	5	0	10
Taking credit/loan	4	8	32	21	5	0	29
Land agreement /contract with Mills	4	7	45	28	3	0	13
Participation in community meetings	5	7	71	13	4	0	0
Participation in meetings at the cooperative	6	10	47	24	11	0	1
Participation in trainings	3	7	76	9	4	2	0
Ownership of agricultural land	0	7	71	17	5	12	0

Ownership of family bank account	2	5	24	37	21	0	0
Ownership of housing	3	7	58	8	22	0	2
Cooking	8	19	62	11	0	16	0
Housekeeping (cleaning, washing, ironing)	3	10	58	8	5	0	0
Child caring	2	31	48	0	13	7	0
Shopping (buying household goods)	6	8	34	40	11	1	0
Gardening(self-consumption kitchen garden)	5	6	38	25	7	1	18
Animal/livestock caring	5	9	45	28	5	0	9

Note: Female = F, Male = M, Girls = G, Boys = B, Hired labor = household outsources task to hired labor, NA = Non Applicable.

Table 14-6: Detailed table of involvement of children in household activities

Share (%) of activities where children (< 18 years old) are active in	**Are children involved in the following activities?**					
	Not at all	Only G	Only B	Both G&B	hired labor	NA
Land preparation	64	1	4	21	10	1
Weeding	60	2	3	24	9	2
Chemical spray	67	0	5	11	8	8
Fertilizing	63	2	4	20	8	4
Harvesting	56	2	4	28	9	1
Post harvesting activities	61	1	3	22	5	8
Maize Transportation to collecting point	45	1	4	15	8	28
Purchasing agricultural inputs	90	0	2	5	1	2
Hiring labor	77	0	0	2	0	20
Selling of maize	83	0	2	4	0	11
Taking credit/loan	68	0	0	2	0	30
Land agreement /contract with Mills	75	1	1	9	0	14
Participation in community meetings	88	0	1	9	0	2
Participation in meetings at the cooperative	95	0	0	2	0	2
Participation in trainings	64	1	4	24	6	0
Ownership of agricultural land	70	2	3	24	0	1
Ownership of family bank account	71	0	5	12	0	12
Ownership of housing	91	0	0	0	0	9
Cooking	43	17	0	31	9	0
Housekeeping (cleaning, washing, ironing)	60	1	3	32	4	0
Child caring	41	10	0	27	14	7
Shopping (buying household goods)	82	5	2	11	1	0
Gardening(self-consumption kitchen garden)	61	0	0	19	0	19
Animal/livestock caring	67	3	3	17	1	9

Note: Female = F, Male = M, Hired labor = household outsources task to hired labor, NA = Non Applicable.

Table 14-7: Detailed table of gender disaggregated access to household resources

Share (%) of resources accessed by	**Who has access to the following resources?**					
	All by F	Mainly by F	equally by M&F	Mainly by M	All by M	NA
Land	3.8	5.9	61	27	2.3	0.2

Agri. Inputs (fertilizer, pesticide)	7.1	6.4	45	37	3	0.9
Extension and training	6.4	7.3	49	28	3.8	5
Technology	4.6	4.9	64	20	1.8	5
Credit/Loan	5.3	7.3	35	24	2.4	25
Marketing/Selling Farmer organizations	5.7	7.1	51	28	1.9	6
Labor	5.1	5.1	41	27	3.5	18
Income	5.1	5.7	66	21	2	0.4
Fixed asset (e.g. house, motorcycle)	5	6	63	24	1.9	0.1
Education for children	3.5	7.8	70	14	1.1	3.3
Expenses on food	5.9	8.7	53	28	4.3	0
Expenses on non-food	8.9	10	53	24	4.6	0
Expenses on maize farming	6.2	6.4	53	29	5	0.06
Social activity	5.1	5.8	77	11	1.7	0

Note: Female = F, Male = M, Hired labor = household outsources task to hired labor, NA = Non Applicable.

Table 14-8: Detailed table of children's access to household resources

Share (%) of activities where children (< 18 years old) have access to	**Are children involved in the following activities?**			
	Not at all	Only G	Only B	Both G&B
Land	67	1.4	2.8	29
Agri. Inputs (fertilizer, pesticide)	92	0.7	1.8	5.8
Extension and training	90	0.8	1.7	7.6
Technology	78	1	2.6	19
Credit/Loan	95	0.2	0.4	4.1
Marketing/Selling Farmer organizations	91	0.9	2.1	5.8
Labor	97	0.4	1.1	1.7
Income	77	1.2	1.6	20
Fixed asset (e.g. house, motorcycle)	70	1.4	2.6	26
Education for children	30	2	2.1	65
Expenses on food	91	0.6	1.1	6.8
Expenses on non-food	93	0.2	0.8	5.6
Expenses on maize farming	93	0.4	1.6	5.1
Social activity	79	0.6	1.7	19

Note: Girls = G, Boys = B, Hired labor = household outsources task to hired labor, NA = Non Applicable.

Table 14-9: Detailed table of gender disaggregated decision making about household resources

Share (%) of resources where decisions are made by	**Who makes decisions about the following resources?**				
	All by F	Mainly by F	equally by M&F	Mainly by M	All by M
Land	5.1	4.3	63	23	4.3
Agri. Inputs (fertilizer, pesticide)	5.5	5	61	24	4.8
Extension and training	5.3	5	63	21	5.3
Technology	4.5	4.6	72	17	2.7
Credit/Loan	5.8	6.5	61	21	5.4
Marketing/Selling Farmer organizations	5.5	6	64	21	3.8
Labor	5.2	5.2	62	22	5
Income	4.8	5.1	72	16	2.5

Fixed asset (e.g. house, motorcycle)	4.2	5.1	65	21	4.6
Education for children	4.2	4.8	77	11	2.9
Expenses on food	5.9	6.7	65	17	4.8
Expenses on non-food	8.2	9.2	60	18	4.9
Expenses on maize farming	5.4	5.1	63	20	6.2
Social activity	4.8	4.8	80	8.4	1.8

Note: Female = F, Male = M, Girls = G, Boys = B, Hired labor = household outsources task to hired labor, NA = Non Applicable.

14.2 Maize production

14.2.1 Maize cultivation patterns

We start by looking at the cultivation patterns of maize. 69% of the maize plots were cultivated with maize only. 29% of the plots were cultivated with maize for at least half of the plot, and the remaining two percent with less than 50% of maize. For those plots that were not entirely cultivated with maize, maize was intercropped with other crops. The major reasons for intercropping are reported in Figure 14-1. The most popular reasons for intercropping are allowing another cash crop to grow (25%), grow another crop to substitute for maize consumption if harvest failure (24%), synergetic effect of intercropping (14) and diversification of diet (12%). Figure 14-2 shows that the main crops with which maize is intercropped are beans (49%), pigeon peas (44%), sunflower (19%) and groundnuts (7%).

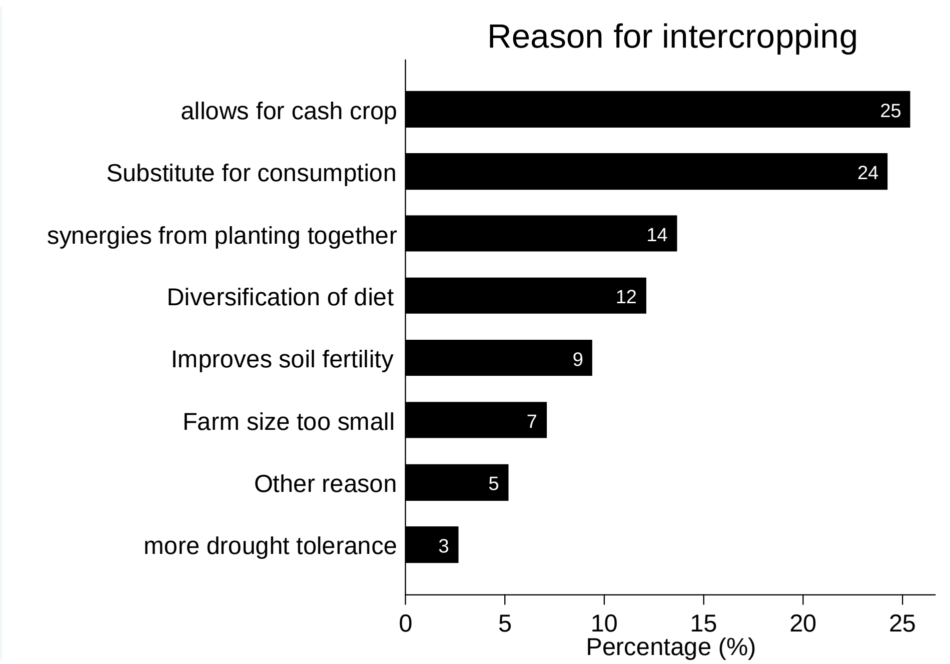


Figure 14-1: Household's reasons for intercropping maize

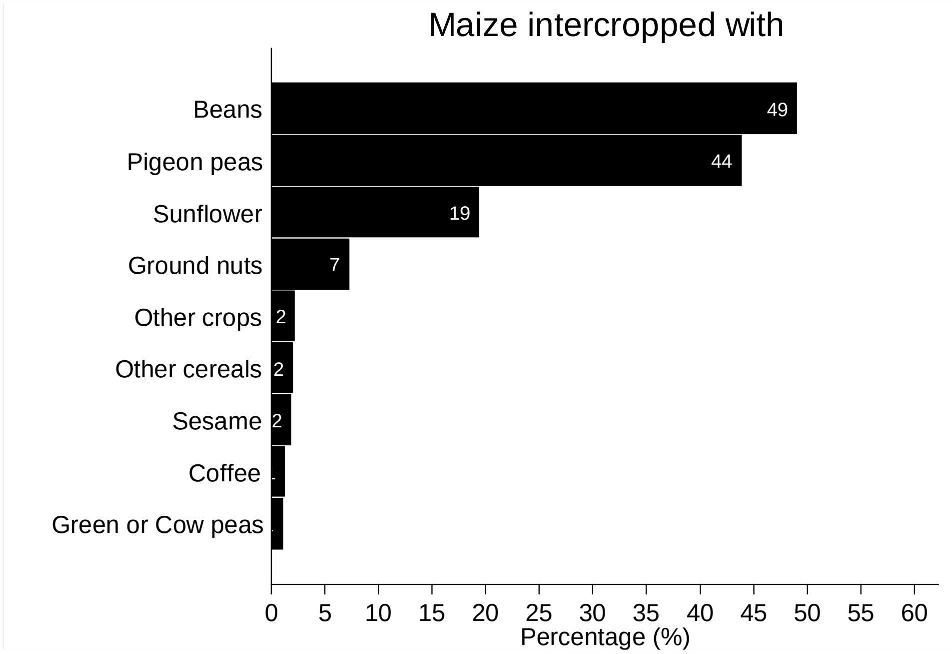


Figure 14-2: Crops with which maize is intercropped

14.2.2 Seed usage (at plot level)

Table 14-10 describes the seed usage of farmers on their individual maize plots. Half of the cultivated maize are sown with improved (hybrid) seeds. The brands of the improved maize seeds used by farmers are displayed in Figure 14-3, and the most common brands are Seedco (46%), Pannar seeds (25%) and Monsanto (15%). Alternatively, 27% and 14% of the maize plots are respectively sown with traditional seeds bought by the household or Open Pollinated Varieties (OPV). 71% of the household assesses the sowing date on their individual maize plot to be normal. Maize plots are mainly directly sowed; using either holes (53%) or furrows (38%). The growth cycle of the maize seeds used by farmers is mainly long (52%), followed by medium (28%) and short (21%).

Table 14-10: Characteristics of maize seeds

Seed application dummies (N=2,143)	Mean	s.d.	Median
Household uses hybrid (improved) maize seed (%)	53	100	50
Household uses Open pollinated variety (OPV) maize seed (%)	14	0	35
Household uses traditional maize seed bought (%)	27	0	45
Household uses maize seed recycled from last year (%)	5	0	22
Planting date is normal (%)	71	100	45
Planting date is early (%)	11	0	32
Planting date is late (%)	18	0	38
Used fixed date to decide on planting date (%)	8	0	27
Used rainfall event to decide on planting date (%)	79	100	41
Used wet soil to decide on planting date (%)	8	0	28
Used other way to decide on planting date (%)	5	0	22

Planted maize by broadcasting (%)	2	0	13
Planted maize by direct furrow seeding (%)	38	0	48
Planted maize by direct hole seeding (%)	53	100	50
Planted maize by other technique (%)	1	0	11
Planted maize by tractor seeding (%)	7	0	25
Seed with short growth cycle (%)	21	0	41
Seed with medium growth cycle (%)	28	0	45
Seed with long growth cycle (%)	52	100	50

Note: 'n' is the number of observation, 's.d.' is the standard deviation

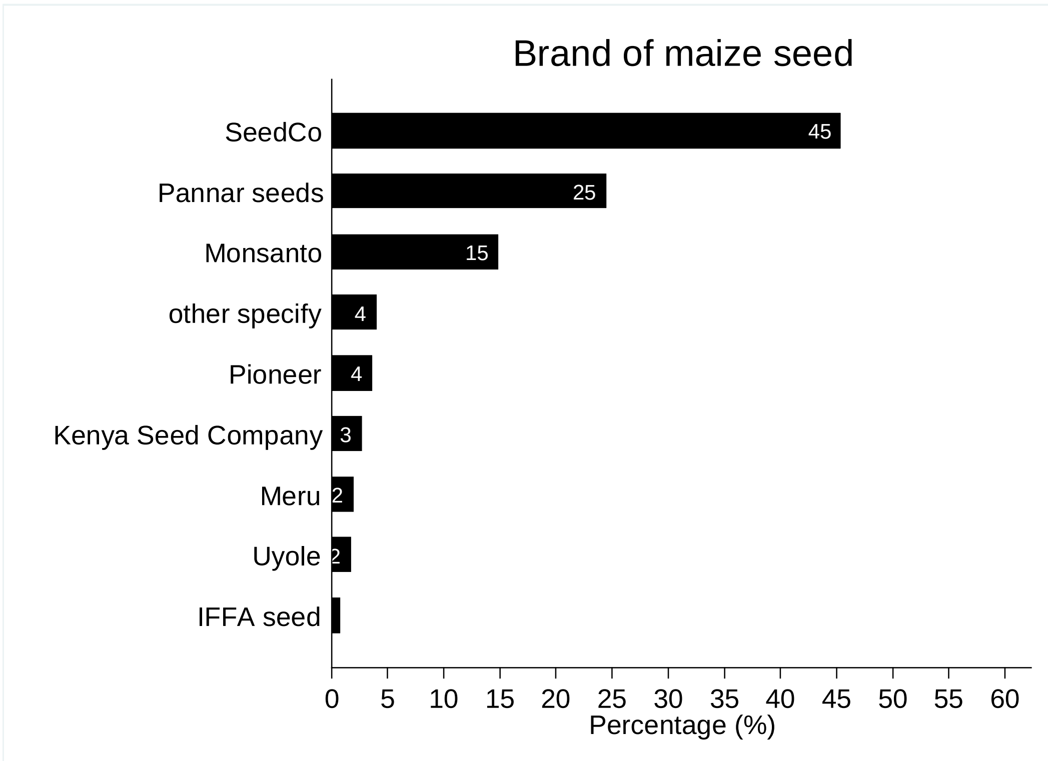


Figure 14-3: Main brands of improved seeds

14.2.3 Modern inputs usage in maize (at household level)

We examine whether households combine the application of different modern inputs on their maize plot. The Venn diagram in Figure 14-4 plots the overlap in households that used (simultaneously) modern seeds, any type of inorganic fertilizer, and any type of pesticide in maize production. We see that 16% of the households simultaneously used the three specified modern inputs (i.e. the inner intersection). Similar shares of households have simultaneously used (i) modern seeds and inorganic fertilizer, (ii) only modern seeds, or (iii) only inorganic fertilizer. Hence, there seem to be only a few households that take benefit of the potential synergetic effects of joint input usage.

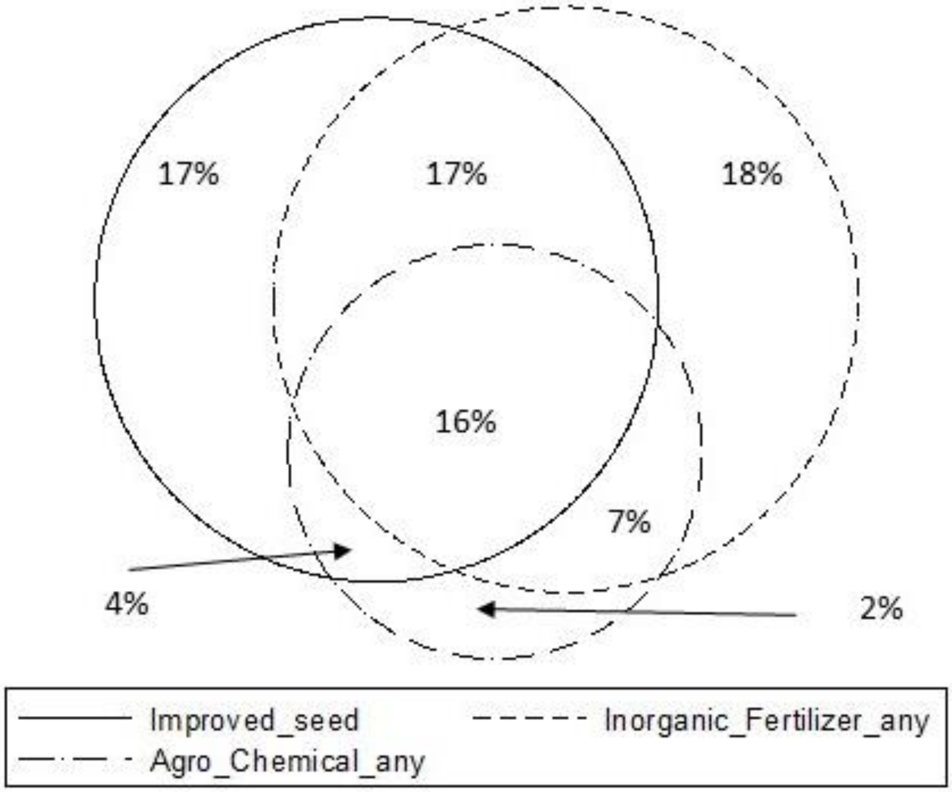


Figure 14-4: Joint input application

We disaggregate the likelihood of the application of modern inputs in maize production over gender, region, farm size and asset value in Table 14-11. Male-headed households are on average more likely to use modern seeds and agro-chemicals than female headed households (differences are statistically significant). One striking observation is that households in the center and north of Tanzania are significantly less likely to use inorganic fertilizer and pesticide in maize production compared to farmers in the south of Tanzania. On the contrary, farmers in the center and north of Tanzania are more likely to use improved seeds and organic fertilizer. All of these differences are significantly different from zero. The application of most modern inputs in maize production does not seem to systematically increase with increasing wealth indicator. However, the use of modern seeds does seem to increase with increasing farm size and asset value quintal.

Table 14-11: Modern input usage in maize production disaggregated over gender, region, farm size and asset value

Modern input application	Improved seeds (%)			Inorganic fertilizer (%)		Pesticide (%)	
	N	Mean	s.d.	Mean	s.d.	Mean	s.d.
Whole sample	1,885	54	50	58	49	29	45
Per sex of household head							
Male	1,589	56	50	59	49	31	46
Female	296	45	50	53	50	22	41

Per region							
South	947	48	50	90	29	38	48
N&C	938	60	49	25	43	21	40
Per farm size quintal							
Q1	570	46	50	65	48	30	46
Q2	341	57	50	63	48	31	46
Q3	237	58	49	59	49	28	45
Q4	360	55	50	57	50	29	45
Q5	377	61	49	44	50	27	44
Per asset value quintal							
Q1	379	47	50	49	50	17	38
Q2	379	50	50	66	48	23	42
Q3	371	59	49	64	48	33	47
Q4	374	56	50	59	49	37	48
Q5	382	58	49	53	50	35	48

Notes: 'N' is the number of observations. Q1 to Q5 represent the first to fifth quantile of the farm size or asset value distribution.

Next, we present the same disaggregated data for the application rates for improved seeds, inorganic fertilizer and pesticide for all households in the baseline sample. The data is reported in relative terms (unit per hectare) and trimmed. Table 14-12 shows that males use on average higher quantities of improved seeds and agro-chemicals on their maize plots. The application rate of improved seeds is slightly higher in the South, but southern households use significantly lower application rates of inorganic fertilizer and agro-chemical. For example, the application rate of inorganic fertilizer is almost twice in the south compared to the center and north of Tanzania. This reflects that adoption rates in Table 14-11. Higher values of farm size or asset value quintal is associated with higher application rates for improved seeds, but the effects are not linear. For inorganic fertilizer and agro-chemicals, the wealth pattern is less clear.[33]

Table 14-12: Modern input application rates in maize production disaggregated over region, farm size and asset value

	N	Mean	s.d.	Mean	s.d.	Mean	s.d.
Whole sample	1,885	9.1	11	107	121	0.6	1.2
Per sex of household head							
Male	1,589	9.4	11	108	121	0.6	1.2
Female	296	7.8	10	102	122	0.4	1.3
Per region							
South	947	8.3	11	181	115	0.8	1.4
N&C	938	10.0	11	32	70	0.4	1.0
Per farm size quintal							
Q1	570	8.8	11	130	126	0.6	1.4

[33] The nonlinear pattern between the household level usage of modern inputs in maize production and farm size (or asset value) is confirmed when plotting the application of inorganic fertilizer or pesticides with respect to farm size (or asset value); and the figures are therefore not reported.

Q2	341	10	11	113	116	0.6	1.1
Q3	237	9.9	11	115	121	0.6	1.2
Q4	360	8.6	10	97	114	0.5	1.1
Q5	377	8.8	10	73	114	0.5	1.3
Per asset value quintal							
Q1	379	7.9	10.0	88	115	0.3	0.9
Q2	379	8.9	11	119	119	0.4	1.0
Q3	371	10	11	115	117	0.7	1.4
Q4	374	9.2	11	119	132	0.8	1.5
Q5	382	9.4	11	96	117	0.7	1.4

Note: 'n' is the number of observation, 's.d.' is the standard deviation. Q1 to Q5 represent the first to fifth quantile of the farm size or asset value distribution.

The disaggregated patterns of application in Table 14-12 might however be diluted by the differential number of zero's (due to different adoption levels). Therefore, Table 14-13 reports the disaggregated application rates for adopting households only. We indeed see that the differences in application rates between the different (sub)groups becomes lower. For example, the differences in use between males and females for modern inputs becomes statistically insignificant; and hence both groups of households are likely to use the same application rates when they adopt modern inputs. The relationship between modern inputs and wealth indicator is not straightforward, and no clear conclusions can be drawn.

Table 14-13: Modern input application rates in maize production disaggregated over region, farm size and asset value - For adopting households

Modern input application	Improved seeds (kg/ha)			Inorganic fertilizer (kg/ha)			Pesticide (l/ha)		
	N	Mean	s.d.	N	Mean	s.d.	N	Mean	s.d.
Whole sample	1,020	17	9	1089	193	110	549	2	4
Per sex of household head									
Male	887	17	8.8	931	192	110	485	2.4	3.3
Female	133	18	8.6	158	197	111	64	3.2	5.2
Per region									
South	457	17	8.9	857	209	111	357	2.7	4.0
N&C	563	17	8.6	232	134	81	192	2.1	2.5
Per farm size quintal									
Q1	262	19	8.1	367	209	111	169	3.0	4.4
Q2	194	18	8.0	215	182	96	107	2.2	2.6
Q3	138	17	8.6	138	199	92	67	2.0	1.6
Q4	197	16	8.8	204	173	100	104	2.2	3.9
Q5	229	15	9.5	165	189	140	102	2.3	3.3
Per asset value quintal									
Q1	180	17	7.8	185	189	117	64	3.8	6.6
Q2	190	18	8.3	248	187	102	88	2.0	2.8
Q3	218	18	8.8	238	182	106	124	2.2	1.8
Q4	210	17	9.1	217	210	116	138	2.1	1.9
Q5	222	17	9.6	201	198	109	135	2.7	4.3

14.2.4 Labor usage

We disaggregate the labor data over gender, region, farm size and asset quintal in Table 14-14. In the last column, we also report whether the mean value of total labor supplied by each sub-group is different from the mean value of the reference group. We first see that male and female households apply similar levels of total labor in maize, although there seems to be a differential contribution of hired and family labor. We also see that farmers in the south apply on average 20 man-days per hectare more than farmers in the north and central of Tanzania. We further observe a significant and substantial negative relationship between labor supply and farm size. This is illustrated in the non-parametric graphs in Figure 14-5. With increasing farm quintal, the total man-days applied to a hectare of maize production decreases, and farmers in the highest farm size quintal apply only one third of the labor supplied by farmers in the lowest farm size quintal. On the contrary, there is no significant effect of asset value on labor application in maize production. However, at high values of assets, the labor applied on maize plots quickly drops.

Table 14-14: Labor inputs in maize production disaggregated over region, farm size and asset value

Labor usage disaggregated	N	Hired labor		Family labor		Total labor		Sign. Diff.
		Mean	s.d.	Mean	s.d.	Mean	s.d.	
Whole sample	1,885	14	36	52	59	66	69	n.a.
Per sex of household head								
Male	1,589	13	38	53	61	66	72	
Female	296	17	22	48	47	65	51	
Per region								
South	947	12	41	64	62	76	73	
N&C	938	15	30	41	54	56	64	***
Per farm size quintal								
Q1	570	16	38	77	68	93	77	
Q2	341	13	18	59	74	72	75	***
Q3	237	18	73	46	37	64	80	***
Q4	360	13	22	41	48	53	52	***
Q5	377	8.8	12	24	27	33	30	***
Per asset value quintal								
Q1	379	12	19	55	56	67	58	
Q2	379	19	71	55	49	74	87	
Q3	371	12	18	51	52	64	53	
Q4	374	11	16	48	52	59	54	*
Q5	382	13	20	53	81	66	84	

Notes: 'N' is the number of observations. Q1 to Q5 represent the first to fifth quantile of the farm size or asset value distribution.

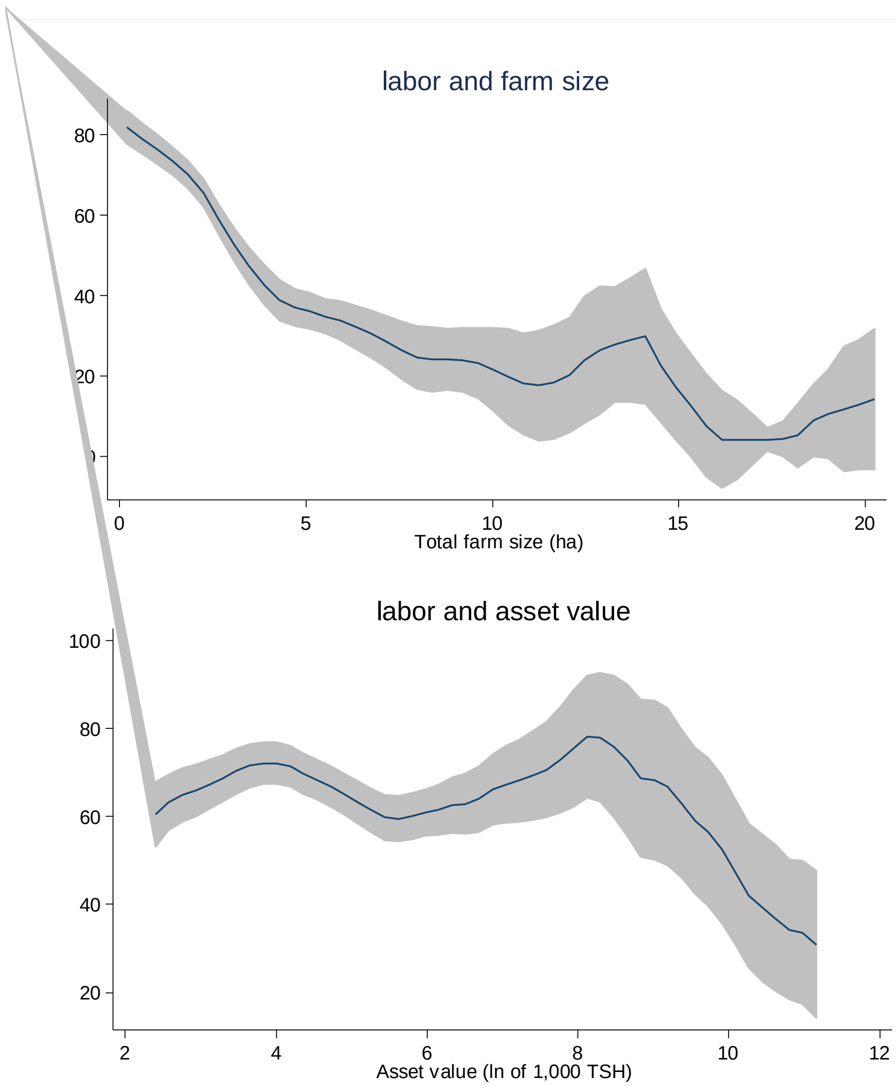


Figure 14-5: Non-parametric graph of labor applied on maize plots (man-days/ha) in function of farm size and asset value.

14.2.5 Mechanization

Table 8-5 shows the uptake and ownership of mechanized equipment over gender, region and wealth indicators. There is no significant difference in uptake of mechanized equipment over gender. Farmers in the north and center of Tanzania make substantially more use of mechanized equipment in maize production, and especially so for tilling the soil. There seems to be a positive association between the uptake of mechanization and farm size, as for nearly all activities in maize production we observe an increasing uptake with increasing farm quintal. The differences in uptake are significant, and strong for the last two quintals. On the contrary, there does not seem to be a strong increase in mechanization of any maize activity with asset value. Only for the last quintal, there is a significant larger share of households (55%) that have any process in maize production mechanized compared to the first quintal (48%).

Table 14-15: The uptake of mechanization in maize production disaggregated over gender, region, farm size and asset value

Farmers used mechanized equipment for	N	any maize process (%)	tilling the soil (%)	weeding (%)	constructing seedrows (%)	harvesting maize (%)	transporting maize (%)	Sign. Diff.?
Whole sample	1,885	48	29	2	8	1	29	n.a.
Per sex of household head								
Male	1,589	47	29	2	9	1	28	
Female	296	51	29	2	6	0	36	
Per region								
South	947	36	3	3	2	1	31	
N&C	938	60	55	2	15	1	27	***
Per farm size quintal								
Q1	570	39	20	2	3	0	23	
Q2	341	44	29	2	6	0	26	
Q3	237	48	26	3	8	0	28	**
Q4	360	50	29	2	9	1	31	***
Q5	377	64	47	3	19	2	41	***
Per asset value quintal								
Q1	379	48	25	2	7	0	33	
Q2	379	45	23	2	6	0	28	
Q3	371	48	32	1	8	1	29	
Q4	374	43	27	2	7	1	23	
Q5	382	55	40	4	14	1	33	*

*Note: 'n' is the number of observation. 'Sign. Diff.?' refers to the significant difference in mean value of the outcome specified in the one but last column between households in different regions, farm size quintals or asset value quintals. These are obtained from the regression of the outcome variable on the region dummy, farm size quintals and asset value quintals; where the first dummy is taken as reference. Q1 to Q5 refer to the first to fifth quintal, South and N&C respectively refer to south Tanzania and central and north Tanzania. The stars refer to the level of significance: *p<0.10, **p<0.05, ***p<0.01, no star: insignificant difference, n.a. means not applicable.*

Table 14-16 further documents on the ownership of machines for tilling the soil, transportation of maize, or any process in maize production (given the low number of mechanization in weeding, constructing seed rows, and harvesting maize; we do not include this ownership data in the table). There is no significant difference in ownership of agricultural machinery between households headed by males or females, or households located in the south and the rest of the country. When looking at the wealth indicators, we see that the ownership of machines is significantly larger for farmers in the higher farm size or asset value quintal.

Table 14-16: Ownership of mechanized equipment in maize production disaggregated over gender, region, farm size and asset value

	any maize process	tilling the soil	transporting maize	Sign. Diff.?

Farmers own mechanized equipment for	**N**	%	**N**	%	**N**	%	n.a.
Whole sample	904	17	552	13	551	17	
Per sex of household head							
Male	754	18	465	13	444	17	
Female	150	17	87	14	107	15	
Per region							
South	337	16	33	30	296	11	
N&C	567	18	519	12	255	23	
Per farm size quintal							
Q1	220	11	112	6	130	10	
Q2	149	14	98	7	89	13	
Q3	114	11	61	3	67	10	
Q4	179	15	105	10	112	15	
Q5	242	30	176	26	153	27	***
Per asset value quintal							
Q1	181	10	93	5	124	6	
Q2	171	10	86	5	108	8	
Q3	179	10	118	3	106	12	
Q4	161	9	101	3	87	5	
Q5	212	42	154	37	126	45	***

*Note: 'n' is the number of observation. 'sign. Diff.?' refers to the significant difference in mean value of the outcome specified in the one but last column between households in different regions, farm size quintals or asset value quintals. These are obtained from the regression of the outcome variable on the region dummy, farm size quintals and asset value quintals; where the first dummy is taken as reference. Q1 to Q5 refer to the first to fifth quintal, South and N&C respectively refer to south Tanzania and central and north Tanzania. The stars refer to the level of significance: *p<0.10, **p<0.05, ***p<0.01, no star: insignificant difference, n.a. means not applicable.*

The uptake of mechanization could be related with the increasing opportunity cost of labor. Therefore, Figure 14-6 shows the relationship between the number of farmers in the village that use mechanization in maize production with the village wage rate. Because wages were asked for specific labor activities separately, we look at the relationship for land preparation. Figure 14-6 shows an increasing – but non-linear – relationship between the number of farmers that have used a machine for tilling the soil and the wage rate in the village for land preparation.

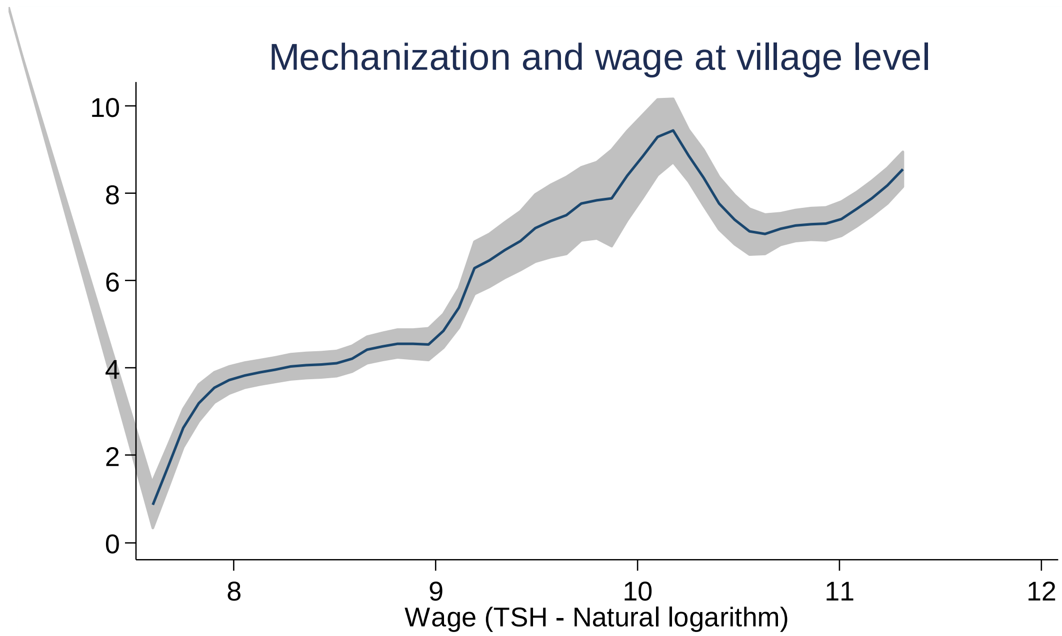


Figure 14-6: Non-parametric graph of mechanization in function of village wage levels

14.2.6 Shocks in Maize production

Households were asked whether they occurred shocks on their maize plots and what type of shocks. 54% of the households responded that they had occurred a shock on their maize plots. For these households, we asked which type of shock happened and at what time during production the shock occurred. Half of the farmers occurred a shock during planting, two out of three face a shock during flowering, and one out of three farmers had a maize shock after the maize had matured. The Venn diagram in Figure 14-7 further suggest that 53% of these households faced at least two shocks, and 14% of the households occurred a shock at each of the tree points in time.

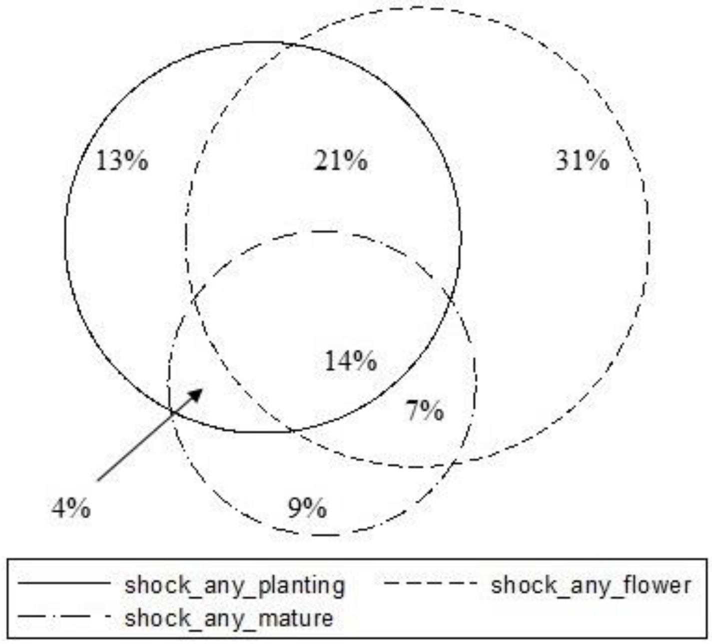


Figure 14-7: Venn diagram of shocks occurred on maize plots during planting, during flowering and after maturing of maize

The most commonly reported shocks in maize production are summarized in Table 14-17. The most important shock to maize production during planting or flowering is having less rain than normal. At the same time, the second most reported shock is having too much rain, showing that both too much and too little rain affects maize production. During flowering and maturing, excessive rainfall can also cause the maize to decay before it is ready to be harvested. Pest, diseases and losses by animal attacks is also an important shock in later stages of maize production. The last panel of Table 14-17 shows how farmers in the different regions in Tanzania are affected by shocks. There seems to be differential shock exposure in south Tanzania compared to the center and north of Tanzania for rainfall patterns and pest shocks.

Table 14-17: Most commonly reported shocks in maize production

Shock	N	During planting %	During flowering %	After maturing %
Shock occurred				
Whole sample	1,885	29	40	18
Those occurring at least one shock	1,023	54	74	32
Type of shock:				
Rains were less than normal		40	41	
Rains were more than normal		18	17	
Rains were later than normal		14		
Maize affected by pests, diseases or eaten by animals		6	10	43
Too high temperature during flowering or maturing			16	
Excessive rainfall caused maize to rot			8	20

Top 5 shocks: South vs. Central and North Tanzania				
Rains were less than normal	South	35	34	
	C&N	45	46	
Rains were more than normal	South	19	20	
	C&N	16	15	
Maize affected by pests, diseases or eaten by animals	South	10	10	37
	C&N	3	10	51
Too high temperature during flowering or maturing	South		10	
	C&N		20	
Excessive rainfall caused maize decay	South		10	26
	C&N		7	13

Note: 'n' is the number of observation. C&N refers to center and north Tanzania

14.2.7 Maize output and yield

Next, we disaggregated maize output and yield over region, farm size and asset value in Table 14-18. We will focus the discussion on maize yield, and the last column reports the results of a regression of maize yield on each of the indicator values to detect for statistical significant differences. Farmers in the south obtain significantly larger maize yields (2.3 ton) compared to farmers in the center and north of Tanzania. While maize output in ton increase with farm size quintal, there is no difference in maize yield between farms of different size. On the contrary, maize yields are significantly higher in larger asset value quintals, although the effect is not linear. These two points are also illustrated graphically in Figure 14-8, which presents the relationship between yield and farm size and asset value.

Table 14-18: Maize harvest and yield disaggregated over region, farm size and asset value.

Maize harvest		Household harvested maize (%)		Maize harvest (ton)		Maize yield (ton/ha)		Sign. Diff.?
	N	Mean	St. Dev.	Mean	St. Dev.	Mean	St. Dev.	
Whole sample	1,885	97	18	3.3	4	2.2	1.6	n.a.
Per sex of household head								
Male	1,589	97	18	3.5	4.1	2.2	1.6	
Female	296	98	15	2.8	3.5	2.1	1.5	
Per region								
South	947	95	22	3.6	4.2	2.5	1.7	
N&C	938	99	12	3.1	3.8	1.9	1.4	***
Per farm size quintal								
Q1	570	96	18	1.4	1.2	2.4	1.8	
Q2	341	96	18	2.3	1.7	2.2	1.5	*
Q3	237	96	20	2.8	2.0	2.1	1.4	
Q4	360	96	19	3.9	3.3	2.2	1.6	**
Q5	377	98	13	7.0	6.5	2.0	1.6	
Per asset value quintal								
Q1	379	98	15	2.2	2.5	2.0	1.5	
Q2	379	97	18	3.0	3.4	2.2	1.6	**
Q3	371	97	17	2.9	3.4	2.1	1.6	

Q4	374	96	19	3.5	3.5	2.2	1.6	**
Q5	382	96	20	5.2	5.7	2.4	1.7	***

Note: 'n' is the number of observation. 'sign. Diff.?' refers to the significant difference in mean value of the outcome specified in the one but last column between households in different regions, farm size quintals or asset value quintals. These are obtained from the regression of the outcome variable on the region dummy, farm size quintals and asset value quintals; where the first dummy is taken as reference. Q1 to Q5 refer to the first to fifth quintal, South and N&C respectively refer to south Tanzania and central and north Tanzania. The stars refer to the level of significance: ∗p<0.10, ∗∗p<0.05, ∗∗∗p<0.01, no star: insignificant difference, n.a. means not applicable.

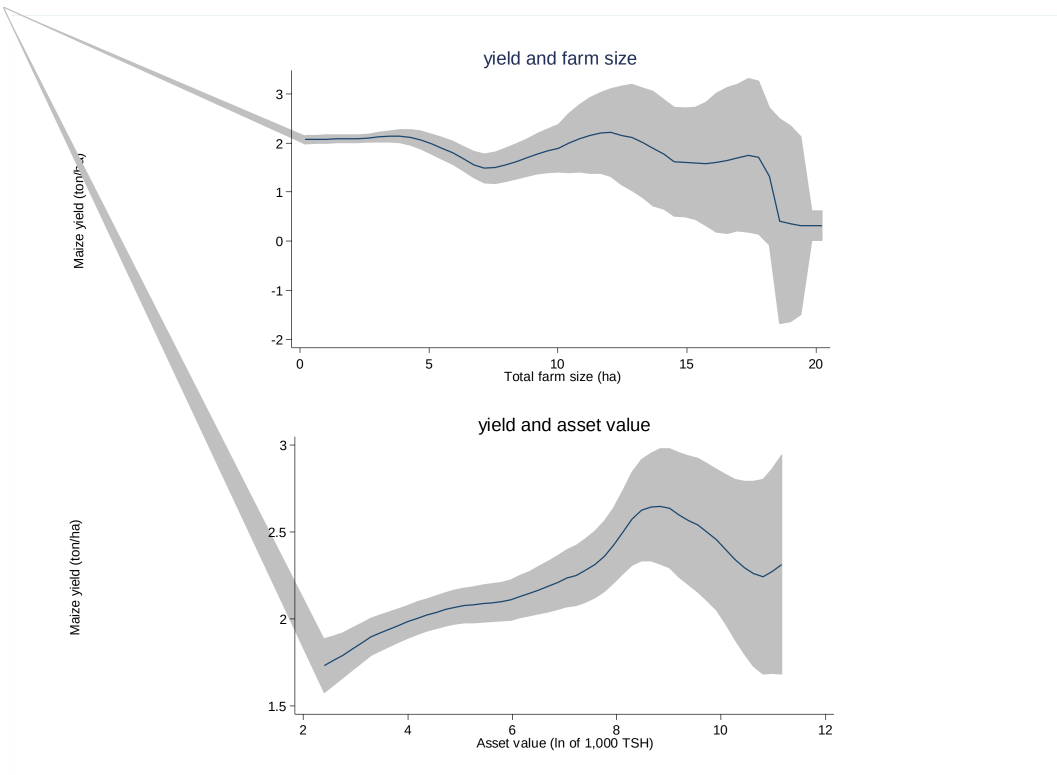


Figure 14-8: Non-parametric graph of maize yield in function of total farm size

14.2.8 Post-harvest handling of maize

Figure 14-9 shows the type of storage facility used by households that store maize. Only a small group of farmers use traditional storage facilities (i.e. locally made structures or unprotected piles), implying that the large majority of farmers that stored maize used an 'improved' storage facility. The most popular method of storage are PICs bags (61%), followed by sacks or open drums (24%). For those farmers using an improved storage facility, we asked their motivation for using them, and the results are shown in Figure 14-10. Most farmers use an improved storage facility because it improves the quality (39%) and quantity (27%) of the maize stored. 18% of the households using an improved storage facility do so to store other crops than maize (18%) or to get a higher price by selling maize at a later period in time (13%).

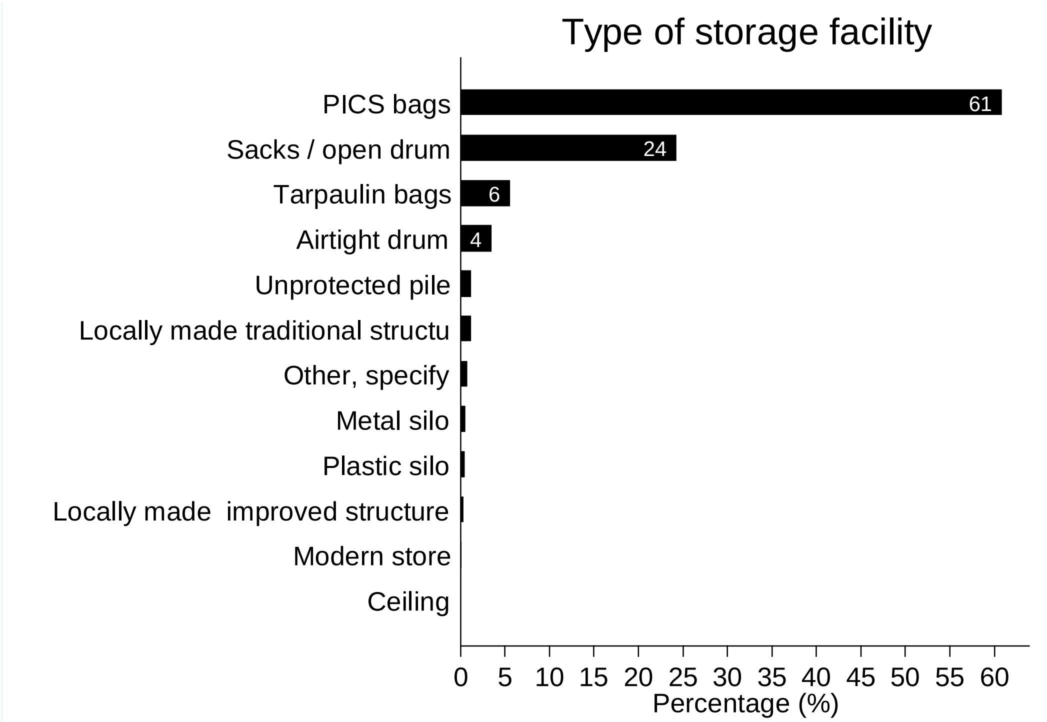


Figure 14-9: Type of storage facility use by households

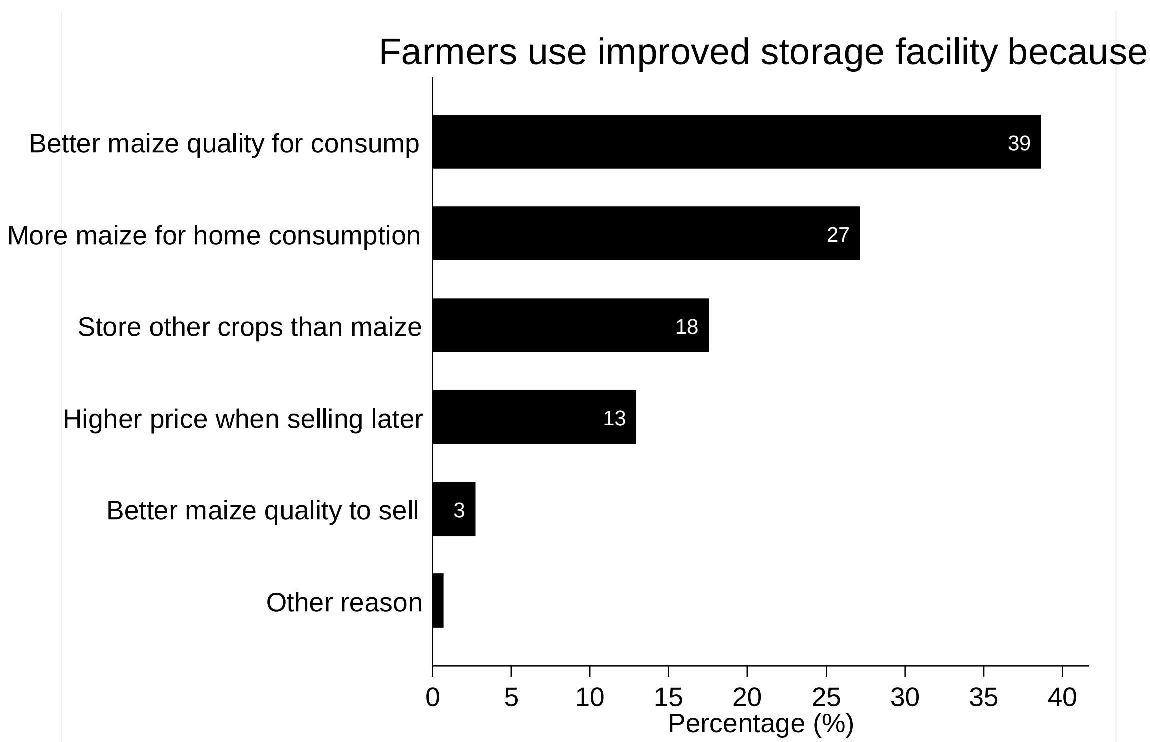


Figure 14-10: Household's reasons to use improved storage facilities

14.3 General crop production systems

14.3.1 Farm size

We disaggregate the farm and maize size data per gender, region and wealth in Table 14-19. Household with male heads tend to have larger farm size and area cultivated with maize compared to female household heads. Table 14-19 suggests that plot sizes are on average larger by half a hectare in the central and north of Tanzania. Similarly, the size of maize production is on average larger in central and north Tanzania but the difference is not significant (Figure 8-2). Table 14-19 further suggests that total farm size and maize size are positively related with asset value. The farm size for households in the lowest asset quintile is 1.6 hectare, while for the households in the largest asset quintile the average farms size is 3.4 hectare. A regression of farm size on the asset value quintiles confirm that the differences per quintal are significant, expect for the first quintal. Similar observations are drawn for the size of maize cultivation.

Table 14-19: Farm size and maize area disaggregated over gender, region and wealth

Modern input application	Farm size (hectare)			Maize area (hectare) (hectare)			Sign. Diff.
	N	Mean	s.d.	N	Mean	s.d.	
Whole sample	1,913	2.1	2.3	1,885	1.8	2.0	n.a.
Per sex of household head							
Male	1,614	2.2	2.4	1,589	1.8	2.1	
Female	299	1.7	1.7	296	1.4	1.5	***
Per region							
South	989	1.9	2	947	1.6	1.7	
N&C	924	2.4	2.6	938	1.9	2.3	**
Per farm size quintal							
Q1	587	0.6	0.2	570	0.6	0.2	
Q2	352	1.2	0.10	341	1.0	0.3	***
Q3	238	1.6	0.08	237	1.3	0.4	***
Q4	370	2.3	0.3	360	1.8	0.6	***
Q5	366	5.7	3.2	377	4.4	3.1	***
Per asset value quintal							
Q1	387	1.6	1.7	379	1.3	1.5	
Q2	389	1.5	1.4	379	1.4	1.4	
Q3	379	2.0	2.2	371	1.6	1.8	***
Q4	383	2.3	2.1	374	1.8	1.7	***
Q5	375	3.4	3.3	382	2.7	2.9	***

Note: 'n' is the number of observation, 's.d.' is the standard deviation

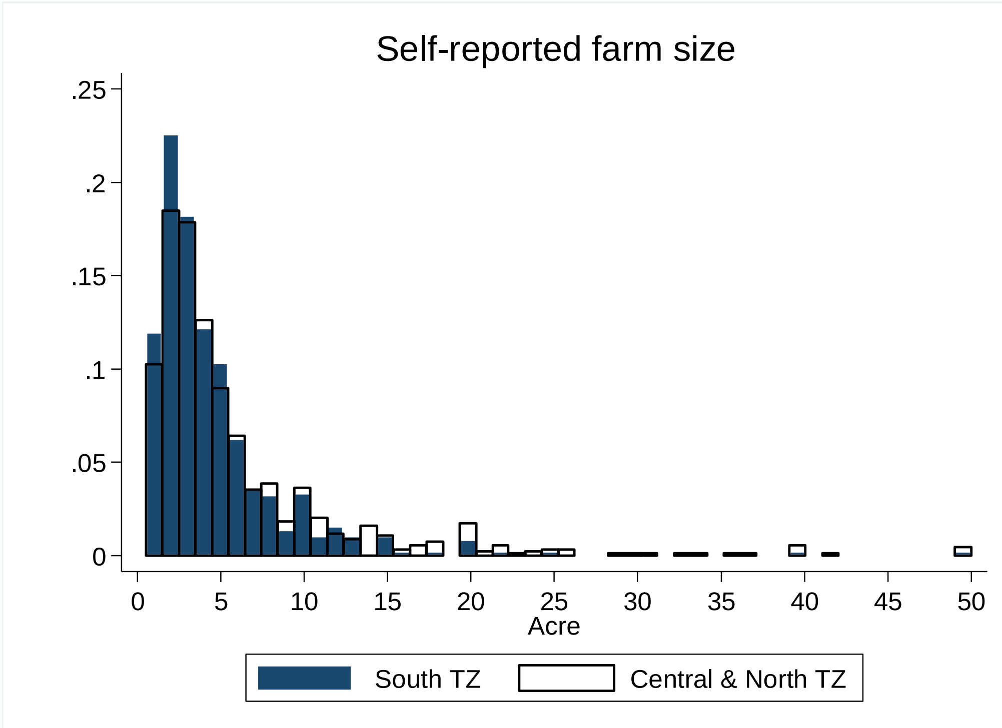


Figure 14-11: Farm size (trimmed in hectare) by region

14.3.2 Cultivation patterns

The households interviewed in our survey listed in total 3,059 plots in the plot roster section. The number of agricultural plots operated by households is reported in Figure 14-12. The majority of farmers just owns one plot (61%). 25% of farmers cultivated two plots, and another 10% cultivated three plots. Very few households (4%) cultivate more than three plots. Of these plots, the large majority (99%) was cultivated by the households themselves. The remaining 26 plots were rented out or given to someone, or left for fallow.

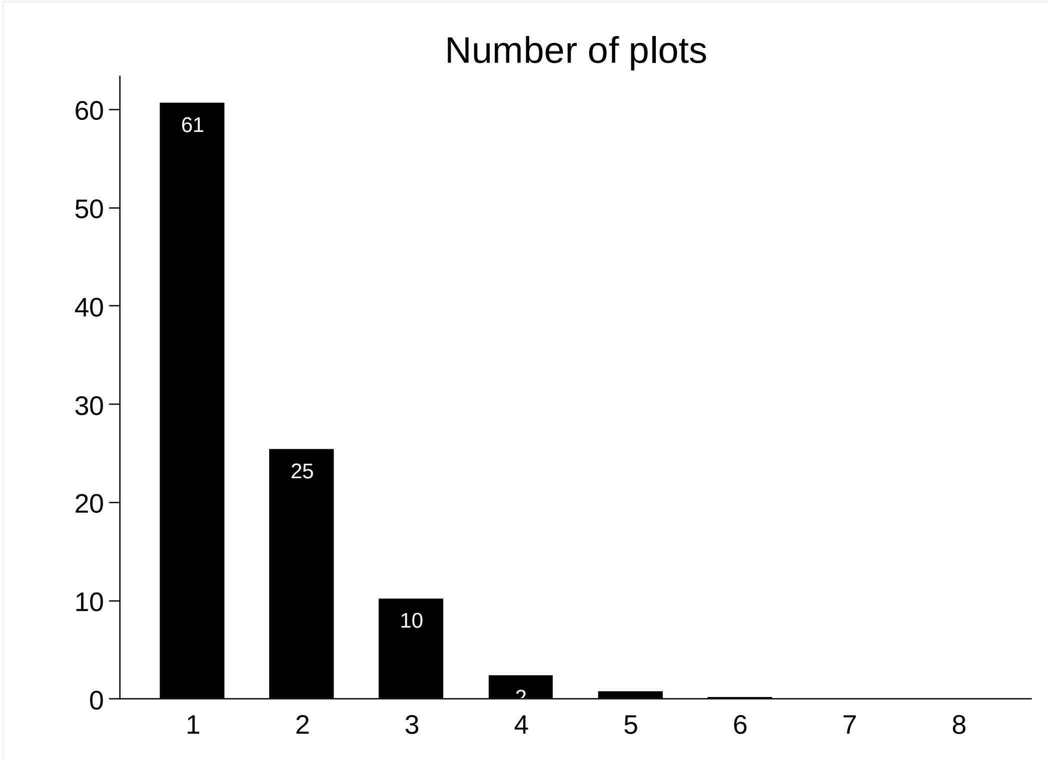


Figure 14-12: Number of plots cultivated by the household

Table 14-20 gives an overview of the characteristics of the all plots listed by the households in the baseline survey. Most of the plots have a flat slope (64%) and have some sort of erosion control infrastructure (52%). The main source of water is rainfall, with less than three of the plots being irrigated. There is significant difference in plot slope and source of rainfall between plots located in south and central and north of Tanzania.

Table 14-20: Plot characteristics of all plots

	Whole sample (N=3,059)		South TZ (N=1,520)		Central and North TZ (N=1,539)		
Plot characteristics	Mean	s.d.	Mean	s.d.	Mean	s.d.	Sign. Diff.
Distance from home to plot (minutes)	43	45	42	42	43	47	
Plot has a flat slope (%)	64	48	58	49	71	46	***
Plot has a slight slope (%)	34	47	41	49	28	45	***
Plot has a steep slope (%)	1.8	13	1.8	13	1.8	13	
Water source on plot is rainfall water (%)	97	17	100	6.8	95	23	**
Water source on plot is irrigation (%)	2.8	16	0.3	5.7	5.2	22	**
Plot has any erosion control (%)	52	50	62	48	41	49	***
Plot has terraces erosion control (%)	30	46	32	47	28	45	
Plot has drainage erosion control (%)	16	36	25	43	6.4	24	***

Note: 'n' is the number of observation, 's.d.' is the standard deviation. 'sign. Diff.?' refers to the significant difference in mean value of the outcome specified in each row between households in different regions. These are obtained from the regression of the outcome variable on the region dummy, where the first dummy is taken as reference. South and

N&C respectively refer to south Tanzania and central and north Tanzania. The stars refer to the level of significance: ∗p<0.10, ∗∗p<0.05, ∗∗∗p<0.01, no star: insignificant difference.

Table 14-21 summarizes the cultivation timing and ownership of the 3,033 plots that are cultivated by the households. Cultivation was mainly done in the long rainy season (88%) or both short and long rainy season (9%). Only few households indicate to only cultivate a plot during the rainy season. 89% of the plots were owned by the household, and 10% of the households rented in the plot. Almost no household had plots that were sharecropped or borrowed without compensation. While there is not much difference between regions in when plots are cultivated, there is significant difference in plot ownership, as in the central and north of Tanzania, a relative larger share of plots are rented in (instead of owned by the household).

Table 14-21: Plot characteristics of plots cultivated by the household

	Whole sample (N=3,033)		South TZ (N=1,507)		Central and North TZ (N=1,526)		
Plot characteristics	Mean	s.d.	Mean	s.d.	Mean	s.d.	Sign. Diff.
Plot is cultivated by the household (%)	99	9.2	99	9.2	99	9.2	
Plot is cultivated in both short and long rainy season (%)	8.8	28	8.0	27	9.6	30	
Plot is cultivated in the long rainy season (%)	87	33	89	32	86	35	
Plot is cultivated by the short rainy season (%)	3.9	19	3.3	18	4.5	21	
Plot is owned by the household (%)	89	31	94	23	84	37	***
Plot is rented in by the household (%)	9.8	30	5.1	22	14	35	***
Plot is sharecropped with other households (%)	0.2	4.4	0	0	0.4	6.3	**
Plot is borrowed from others without compensation (%)	0.8	8.9	0.5	6.8	1.1	10	

Note: 'n' is the number of observation, 's.d.' is the standard deviation. 'sign. Diff.?' refers to the significant difference in mean value of the outcome specified in the one but last column between households in different regions, farm size quintals or asset value quintals. These are obtained from the regression of the outcome variable on the region dummy, farm size quintals and asset value quintals; where the first dummy is taken as reference. Q1 to Q5 refer to the first to fifth quintal, South and N&C respectively refer to south Tanzania and central and north Tanzania. The stars refer to the level of significance: ∗p<0.10, ∗∗p<0.05, ∗∗∗p<0.01, no star: insignificant difference, n.a. means not applicable.

Finally, Table 14-22 and Figure 14-13 shows the crop production patterns for the whole sample and over different regions. We only take into account crops cultivated by at least 2% of the households in our sample. In general, maize is the main crop cultivated, as 72% of the plots in our sample are cultivated with maize. This pattern is the same between the regions. Maize cultivation is often combined with cash crops like beans, sunflower, groundnut or coffee production. There are however, important difference is secondary crops, following local suitability of crop production. In the south of Tanzania, beans and coffee are the most important cash crops; while in the center and north of the country sunflower is more important.

Table 14-22: Most popular cultivated crops by region

	Whole sample (N=3,059)	South TZ (N=1,520)	Central and North TZ (N=1,539)

Plot is cultivated with	Mean	s.d.	Mean	s.d.	Mean	s.d.	Sign. Diff.
Maize (%)	72	45	72	45	73	45	
Beans (%)	8.1	27	11	31	5.8	23	***
Sunflower (%)	4.1	20	1.1	10	7.0	26	***
Groundnut (%)	3.3	18	5	22	1.6	12	***
Coffee (%)	4.6	21	7.5	26	1.7	13	***
Other crops (%)	7.6	26	3.9	19	11	32	***

*Note: 'n' is the number of observation, 's.d.' is the standard deviation. 'sign. Diff.?' refers to the significant difference in mean value of the outcome specified in the one but last column between households in different regions. These are obtained from the regression of the outcome variable on the region dummy, where the first dummy is taken as reference. South and N&C respectively refer to south Tanzania and central and north Tanzania. The stars refer to the level of significance: *p<0.10, **p<0.05, ***p<0.01, no star: insignificant difference, n.a. means not applicable.*

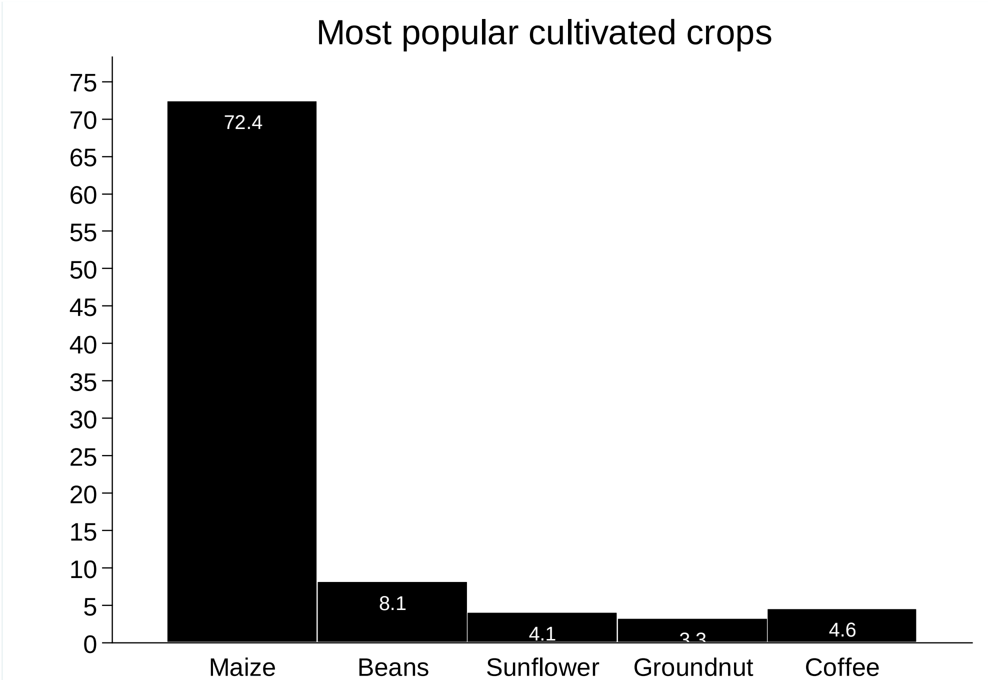


Figure 14-13: Most popular cultivated crops

14.3.3 Plot size

Table 14-23 reports summary statistics of the (trimmed) plot size for different crops and plot ownership status. On average, the plot size over all crops is 1.4 hectares, and this is not different across regions in Tanzania. If we compare plot size between crops on cultivated plots, we see that maize and sunflower plots are on average larger (1.5 and 1.4 ha respectively) than beans, groundnut or coffee. Again, there are differences in plots size for different crops across regions, reflecting the cultivation patterns in Table 14-22 above. Most notably the plot sizes of sunflower are on average one hectare larger in the central and north of Tanzania.

Table 14-23: Plot sizes over crops and ownership status.

	Whole sample (N=3,059)		South TZ (N=1,520)		Central and North TZ (N=1,539)		
Plot size	Mean	s.d.	Mean	s.d.	Mean	s.d.	Sign. Diff.
All crops on all plots	1.4	1.5	1.2	1.4	1.5	1.6	**
All crops on cultivated plots	1.4	1.6	1.2	1.4	1.5	1.6	*
All crops on cultivated plots owned by household	1.4	1.6	1.3	1.5	1.5	1.6	*
Maize on cultivated plots	1.5	1.6	1.4	1.5	1.6	1.7	
Beans on cultivated plots	0.8	0.7	0.7	0.6	0.9	0.8	*
Sunflower on cultivated plots	1.6	1.5	0.7	0.8	1.7	1.6	***
Groundnut on cultivated plots	0.6	0.5	0.5	0.4	0.9	0.7	*
Coffee on cultivated plots	0.9	1.0	1.0	1.1	0.7	0.5	**

*Note: 'n' is the number of observation, 's.d.' is the standard deviation. 'sign. Diff.?' refers to the significant difference in mean value of the outcome specified in the one but last column between households in different regions. These are obtained from the regression of the outcome variable on the region dummy, where the first dummy is taken as reference. South and N&C respectively refer to south Tanzania and central and north Tanzania. The stars refer to the level of significance: *p<0.10, **p<0.05, ***p<0.01, no star: insignificant difference, n.a. means not applicable.*

Figure 14-14 shows the distribution (and kernel density) of plot sizes of all plots. Many farmers respond to have plots of the size of 1, 2, 3, or 4 acres; which corresponds with the heaps in Figure 14-14 around 0.4, 0.8, 1.2, and 1.6 ha. 58% of the plots is less than one hectare and 85% of the plots are less than two hectares.

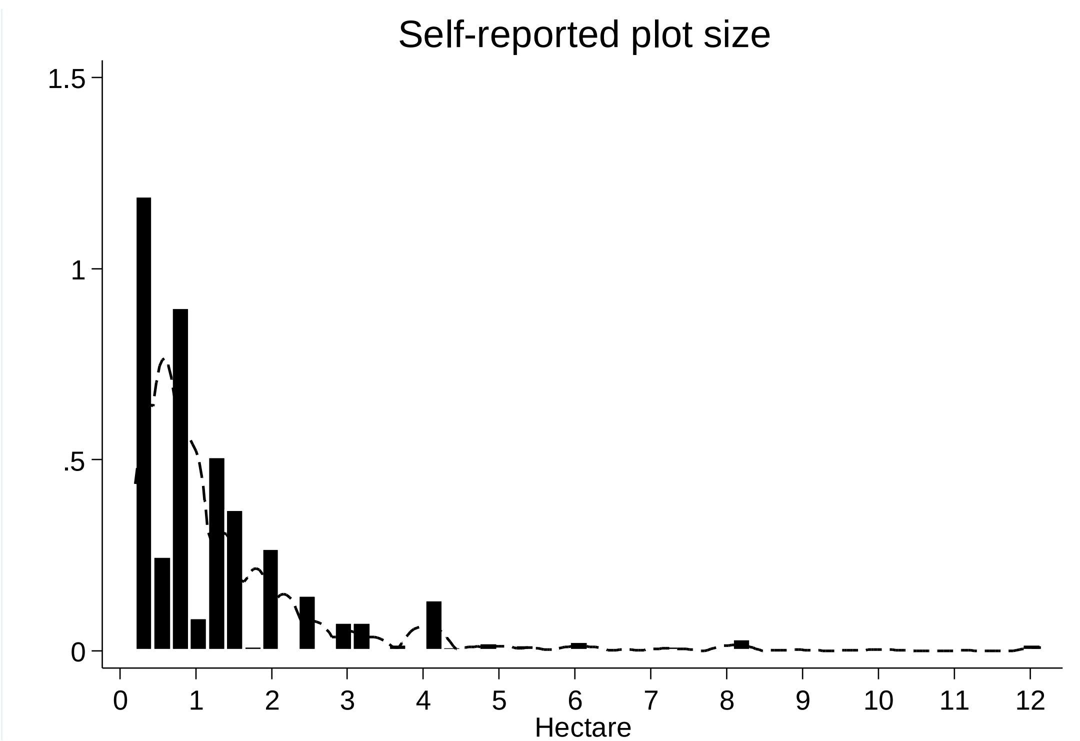


Figure 14-14: Distribution of (trimmed) plot size

14.3.4 Other crops income

Households were asked to report input usage, expenditures, harvest and marketing outcomes for all crops other than maize. Table 14-24 below reports the shares of households that used (modern) inputs, harvested, and sold the crop for the five most popular crops of (i.e. most often cultivated by) the surveyed farmers. These popular crops are respectively beans, sunflower, pigeon peas, groundnut and coffee; which all can be considered as cash crops. The use of modern inputs (i.e. improved seeds, inorganic fertilizer and agro-chemicals) is low for the food cash crops. Substantially more farmers use these inputs in coffee production. Almost none of the surveyed households used credit to buy any of the inputs for the most popular crops. For all other crops, there is a high share of households (that harvested the crop) who are selling part of their harvest.

Table 14-24: Input application in crop production of 5 most popular crops other than maize

Other crops	**Beans (N=822)**		**Pigeon Peas N=276**		**Sunflower N=286**		**Groundnut N=267**		**Coffee N=208**	
	mean	s.d.	mean	s.d.	mean	s.d.	mean	s.d.	mean	s.d.
INPUTS: share of households that used										
improved seeds (%)	12	32	5.1	22	6.6	25	11	32	10	30
organic fertilizer (%)	6.2	24	8.0	27	5.6	23	2.6	16	35	48
inorganic fertilizer (%)	8.5	28	0.4	6.0	1.0	10	0	0	47	50
agro-chemicals (%)	16	37	8.0	27	2.8	17	0.7	8.6	55	50
credit to buy inputs (%)	1.0	9.8	0	0	0	0	0.4	6.1	1.9	14
OUTPUT: share of households that										
harvested (%)	96	20	98	13	99	12	98	14	95	22
sold (part) of harvested output	61	49	88	33	67	47	63	48	97	16

Note: 'n' is the number of observation, 's.d.' is the standard deviation

Table 14-25 reports the harvest and marketing outcomes for the five most popular crops for those households that grew the crop in consideration. The last two columns show that the production of coffee results in the highest net revenue (i.e. value of sales minus expenditures on modern inputs and hired labor).[34] [35] If we deduct the household's expenditure on non-labor inputs from the value of sales, households that grow coffee on average earn 442 USD from coffee production. However, this is the income from sales for households that grow the specific crop, and Table 14-26 reports the sample averages after replacing missing values by zero. The average net income from sales of

[34] The cost of hired labor is calculated as the product of the number of man-days of labor applied with the village level wage rate (the average of the village wage rate for land preparation, weeding, harvesting and post harvesting).

[35] Thi sis irrespective of how labor costs are calculated, in this case only hired labor. When family labor costs are taken into account, a similar pattern occurs.

coffee for the whole baseline sample is 44 USD per household. With respect to the other cash crops, pigeon peas yield the second highest revenue, and groundnut the lowest.

Table 14-25: expenditure, harvest quantity, sales and net income of 5 most popular crops other than maize

		Input expenditure (USD) on		*Crop output*			*Crop income from sales (USD)*	
		Non-labor inputs	Hired labor	Harvest quantity (ton)	Sales quantity (ton)	Sales price (TSH/kg)	Gross income	Net income
Beans	N	822	822	789	480	480	480	480
	mean	8.9	29	0.4	0.5	1,285	249	198
	s.d.	31	67	0.7	0.7	1,580	459	430
Pigeon Peas	N	276	275	271	238	238	238	237
	mean	1.8	24	0.7	0.7	1,121	282	256
	s.d.	6.8	45	0.9	0.9	1,418	350	345
Sunflower	N	286	285	282	188	188	189	188
	mean	1.1	37	0.9	0.8	728	193	148
	s.d.	6.1	84	1.3	1.0	1,984	284	285
Groundnut	N	267	266	262	166	166	166	166
	mean	1.9	11	0.6	0.5	689	111	94
	s.d.	7.5	28	0.7	0.5	726	143	144
Coffee	N	208	208	197	192	192	192	192
	mean	46	24	0.6	0.6	2,754	517	442
	s.d.	73	72	1.2	1.1	1,717	875	849

Note: 'n' is the number of observation, 'μ' is the mean, 's.d.' is the standard deviation

Table 14-26: expenditure, harvest quantity, sales and net income of 5 most popular crops other than maize for all households

N=1,933	**Beans**		**Pigeon Peas**		**Sunflower**		**Groundnut**		**Coffee**	
	mean	s.d.	mean	s.d.	mean	s.d.	mean	s.d.	mean	s.d.
Input expenditure (USD) on										
Total non-labor inputs	3.8	20	0.3	2.6	0.2	2.4	0.3	2.9	4.9	28
Hired labor	12	46	3.3	19	5.5	35	1.5	11	2.6	25
crop output										
Harvest quantity (ton)	0.2	0.5	0.09	0.4	0.1	0.6	0.08	0.3	0.06	0.4
Sales quantity (ton)	0.1	0.4	0.08	0.4	0.08	0.4	0.04	0.2	0.06	0.4
Crop income from sales (USD)										
Gross income	62	253	34	148	19	106	9.5	52	51	316
Net income	49	231	31	141	14	99	8.1	50	44	298

Note: 'n' is the number of observation, 'μ' is the mean, 's.d.' is the standard deviation

14.4 Economics of maize production

14.4.1 Maize input expenditure

Table 14-27 compares expenditure on improved seeds, inorganic fertilizer (all types combined), agro-chemicals (all types combined), and total inputs over gender, regions, farm size quintals and asset value quintals. Male-headed households on average spend 8 USD more on maize inputs (in total) per hectare than female households, but this difference is not statistically significant from zero. There is, however, a very clear geographical difference. Farmers in the south of Tanzania significantly spend more on inorganic fertilizer in maize production, making their total expenditure in maize significantly larger compared to farmers in the rest of the country. This pattern reflects the geographical pattern of different uptake rates of modern inputs (Table 14-12). The total expenditure on all modern inputs combined seems to be declining with increasing farm size quintal. However, as the graphs in Figure 14-15 show, there is no linear relationship between expenditure on improved seeds, inorganic fertilizer, agro-chemicals or total input usage and the size of the farm. Similarly, both Table 14-27 and Figure 14-15 do not suggest a linear relationship between the expenditure on improved seeds, inorganic fertilizer or agro chemicals and the asset value. However, the last graph of Figure 14-15 shows that the total expenditure on all inputs increases slightly with increasing asset value, but the drops sharply at the higher end of the asset value distribution.

Table 14-27: Relative input expenditure (per total maize plot size) disaggregated over region, farm size, and asset value.

Input expenditure (USD/ha)	N	Improved Seeds		Inorganic Fertilizer		Agro-Chemicals		Total inputs		
		Mean	s.d.	Mean	s.d.	Mean	s.d.	Mean	s.d.	sign diff
Whole sample	1,885	32	34	58	74	2	6	96	93	n.a.
Per sex of household head										
Male	1,589	33	34	59	73	2	7	98	92	
Female	296	27	33	55	76	1	5	89	95	
Per region										
South	947	30	34	99	76	3	7	135	99	
N&C	938	34	35	17	42	2	6	56	65	***
Per farm size quintal										
Q1	570	34	37	72	81	3	8	112	100	
Q2	341	35	38	60	72	2	6	102	89	
Q3	237	36	36	57	71	1	4	97	90	*
Q4	360	29	29	52	66	2	6	87	82	***
Q5	377	27	30	42	70	2	5	75	90	***
Per asset value quintal										
Q1	379	24	29	47	67	1	4	77	86	
Q2	379	31	33	61	68	2	5	99	89	***
Q3	371	34	38	63	79	3	8	101	95	***
Q4	374	33	33	65	81	3	7	103	97	***
Q5	382	38	37	56	73	3	7	102	94	***

Note: 'n' is the number of observation, 's.d.' is the standard deviation. Q1 to Q5 represent the first to fifth quantile of the farm size or asset value distribution.

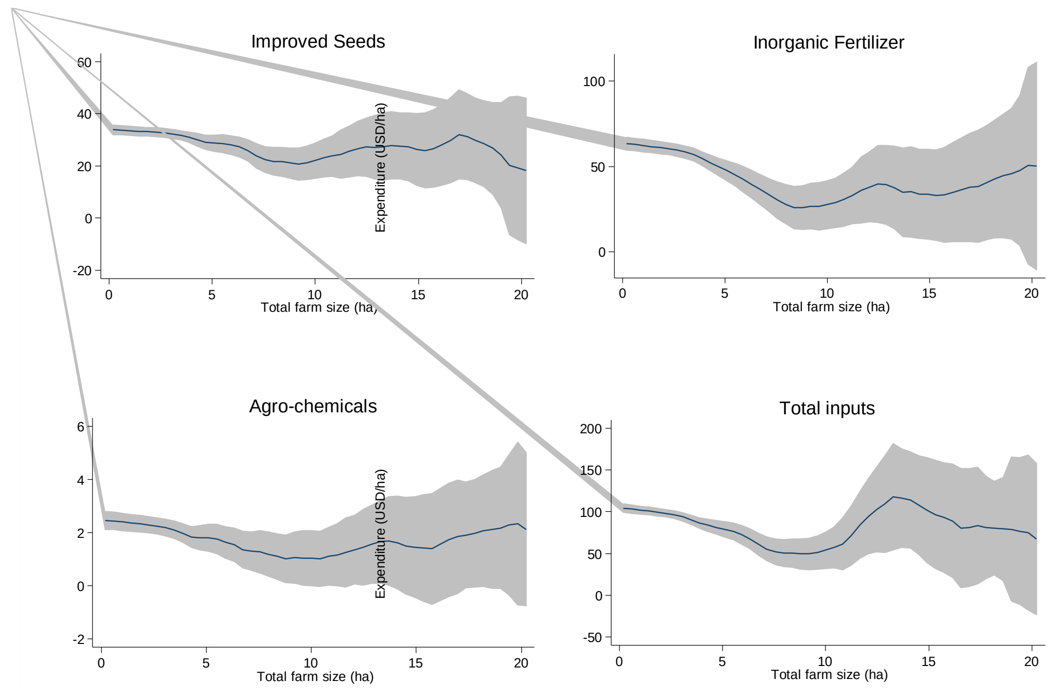


Figure 14-15: Non-parametric graph of input expenditure in function of farm size

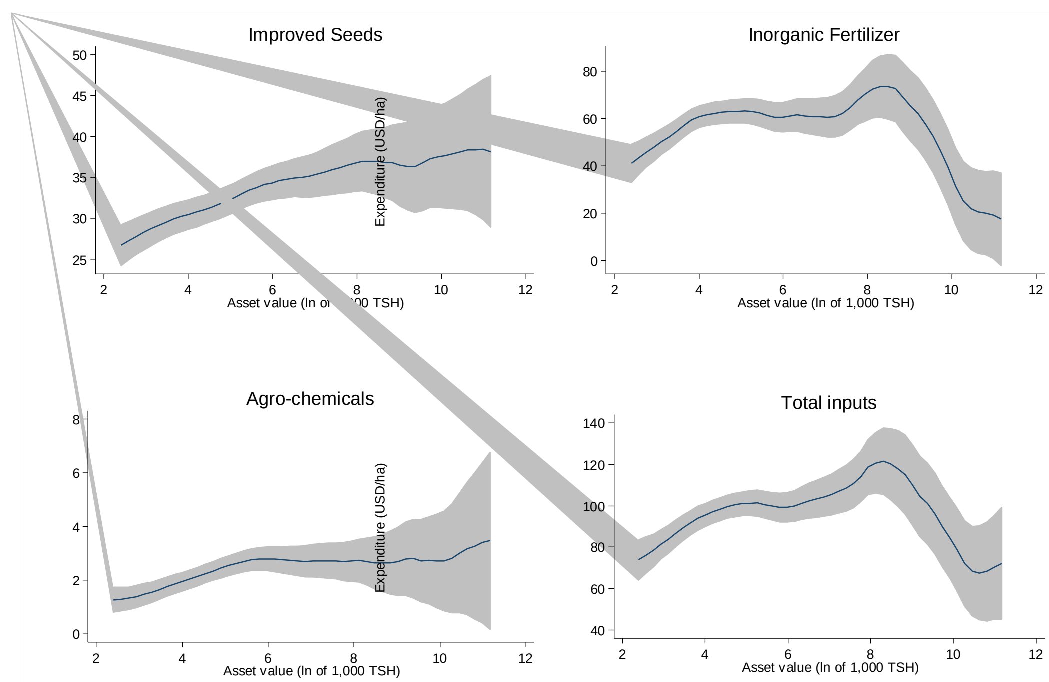


Figure 14-16: Non-parametric graph of input expenditure in function of asset value

Finally, we collected qualitative data on how farmers decide on using an input and where farmers purchase them. The results are graphically displayed in Figure 14-17 where the responses were aggregated over all inputs. On average and over all input types, half of the farmers use their own experience to decide on the use of an input. 30% of the farmers makes decisions based on advice from agricultural extension agents and 12% based on advice from their neighbors. Moreover, if we look at information sources for each input types individually, the same decision patterns are observed (results are not reported).

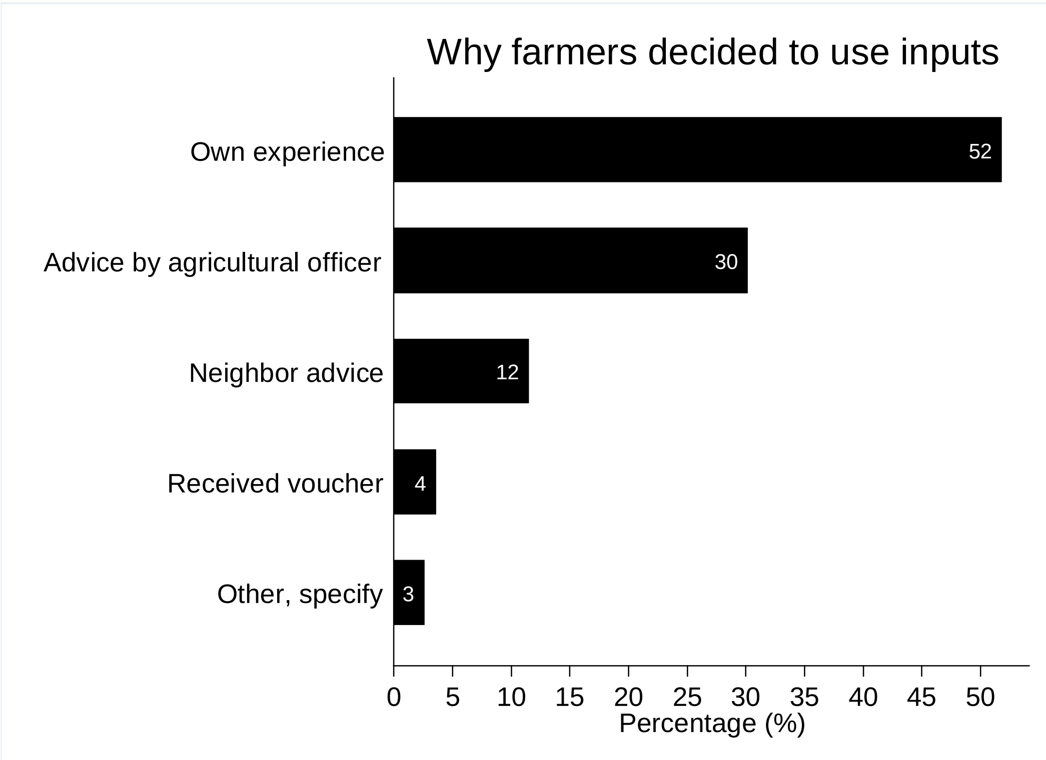


Figure 14-17: Reasons why farmers decide to use inputs

Next, we asked where farmers bought (most of) the inputs used on their maize plots during the last production season. Figure 14-18 shows the results. Three out of four farmers bought their inputs from local agro-dealers. 12% of the farmers used inputs that came from own production (especially manure) and 5% of the farmers bought their inputs from neighbors or the local farmer organization. There is little variation in the source of input seller over the different individual inputs, except for manure that is mainly from own production or from neighbors (results not reported).

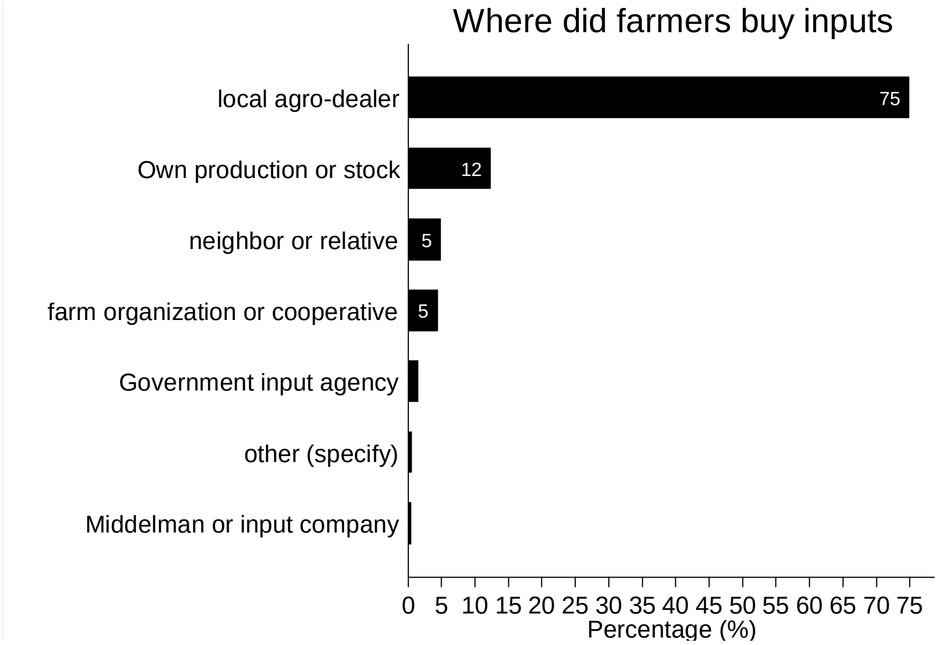


Figure 14-18: Where farmers buy their maize inputs

Finally, we asked farmers how they financed the input purchases in maize production. Figure 14-19 shows that the large majority of the maize farmers used cash out of the pocket to finance inputs. 4% of the households did not buy the inputs and received it free, and 4% received the input from a government input voucher program. Only 2% of the farmers purchased inputs on credit to be repaid later. Given the low number of households that used credit for any type of households (only 49 farmers financed inputs by credit), disaggregating the purchase numbers makes little sense.

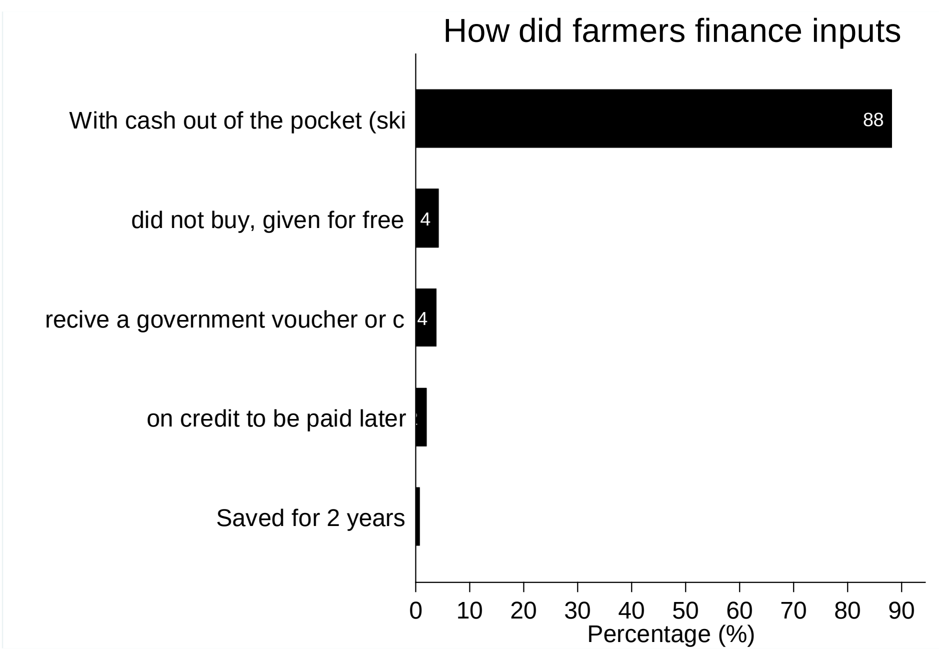


Figure 14-19: Sources of maize input finance

14.4.2 Hired labor cost

Table 14-28 summarizes the hired labor cost disaggregated over gender, region, farm size and asset value. Female farmers spend on average 10 USD per hectare maize on hired labor, and this difference is statistically significant. Farmers located in the north and center also spend significantly more on hired labor compared to farmers in the South. Farmers with larger farm size tend to spend less on hired labor, although the difference is statistically significant for the last two quintals. Finally, there seems to be no clear relationship between expenditure on (hired) labor and the asset value.

Table 14-28: Hired labor cost disaggregated over gender, region, farm size and asset value

Labor cost (USD/ha)	N	Maize preparation		Input application		Harvesting		Post-Harvest handling		Total hired labor		
		Mean	s.d.	Mean	s.d.	Mean	s.d.	Mean	s.d.	Mean	s.d.	sign diff
Whole sample	1,885	8	14	15	25	7	11	2	4	32	47	n.a.
Per sex of household head												
Male	1,589	7	14	14	24	6	11	2	4	31	45	
Female	296	10	16	19	31	8	12	3	6	41	52	***
Per region												
South	947	6	12	9	18	5	10	2	4	24	39	
N&C	938	9	16	21	29	8	12	2	4	41	52	***
Per farm size quintal												
Q1	570	9	17	18	30	7	12	3	5	39	56	
Q2	341	8	15	15	26	7	12	2	4	34	48	
Q3	237	9	15	17	28	7	12	2	5	37	46	
Q4	360	6	12	12	19	6	10	2	4	28	40	***
Q5	377	5	11	10	16	5	10	1	2	23	32	***
Per asset value quintal												
Q1	379	7	15	14	25	7	12	2	4	30	46	
Q2	379	9	14	17	30	6	10	2	5	37	52	*
Q3	371	8	14	16	26	7	11	2	4	35	48	
Q4	374	7	13	12	20	6	10	2	4	28	38	
Q5	382	8	15	14	23	8	13	2	4	33	48	

Note: 'n' is the number of observation, 's.d.' is the standard deviation. Q1 to Q5 represent the first to fifth quantile of the farm size or asset value distribution.

14.4.3 Maize marketing

Figure 14-20 gives an overview of the reasons why framers had to sell maize. 61 % of the maize selling farmers sold maize because they needed extra cash, and 17% indicated that they had to pay-off debts for school fees or health services.

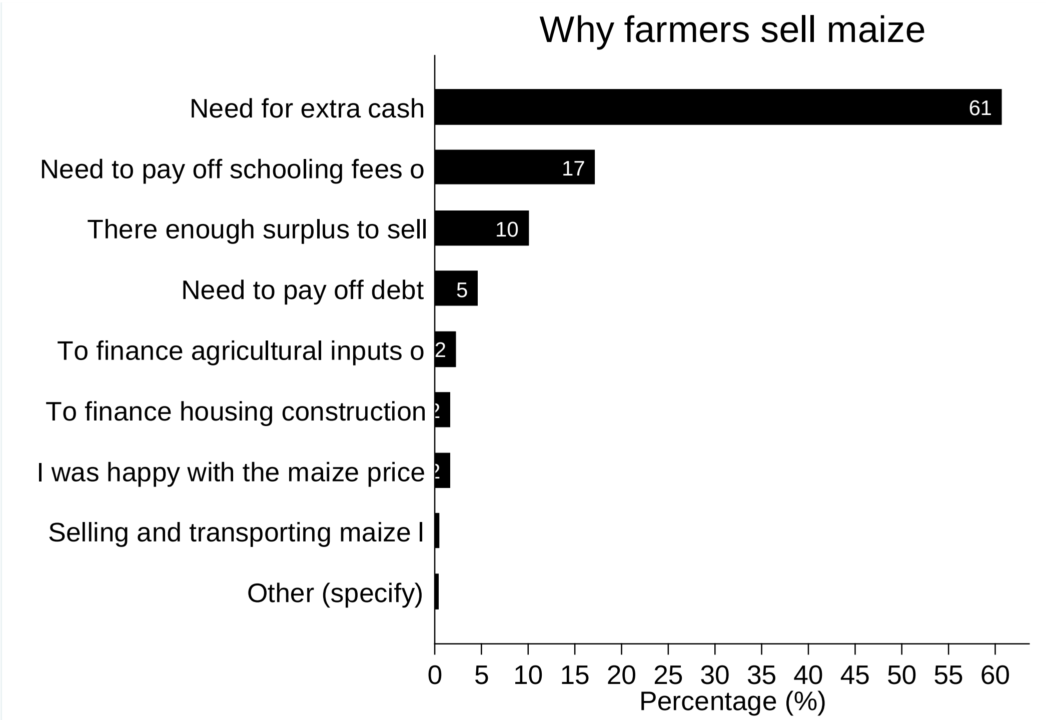


Figure 14-20: Reasons why farmers sell maize

We compare the marketing behavior of maize selling farmers over different regions, farm size quintals and asset value in Table 14-29. The share of maize farmers that sold part of their maize harvest is not significantly different between regions. However, the percentage of households selling maize does increase with farm size quintal. This share is similar between households that are in the fourth asset quintal or below, but the share of households that sold maize in the last quintal of asset value is significantly larger than the rest. The (trimmed) total quantity sold by maize selling households is not significantly different between regions, but it does increase significantly with both farm size and asset value quintal. Finally, the same pattern of disaggregated differences in mean values occurs for the total value of the maize sales. Again, these last two points are graphically illustrated in the Figure 14-21 and Figure 14-22.

Table 14-29: Maize marketing disaggregated over gender, region, farm size and asset value

Maize marketing	Household sold maize (%)			Total quantity (ton/ha)			Price (TSH/kg)		Total value (USD/ha)		Sign. Diff.?
	N	mean	s.d.	N	mean	s.d.	mean	s.d.	mean	s.d.	
Whole sample	1,885	64	48	1,220	1.5	1.2	192	79	276	246	n.a.
Per sex of household head											
Male	1,589	65	48	1,034	1.5	1.3	192	79	277	244	
Female	296	63	48	186	1.4	1.1	187	80	268	258	
Per region											
South	947	67	47	630	1.6	1.3	182	83	285	253	
N&C	938	63	48	590	1.3	1.1	202	74	266	238	
Per farm size quintal											
Q1	570	52	50	282	1.5	1.1	187	71	272	225	

Q2	341	65	48	220	1.4	1.1	183	82	245	219	
Q3	237	67	47	159	1.4	1.1	200	94	267	227	
Q4	360	71	45	257	1.6	1.4	194	91	281	256	
Q5	377	76	43	288	1.6	1.3	197	63	303	283	
Per asset value quintal											
Q1	379	61	49	233	1.3	1.1	198	84	248	221	
Q2	379	63	48	238	1.6	1.3	191	88	275	230	
Q3	371	64	48	236	1.4	1.2	192	78	275	240	
Q4	374	64	48	240	1.4	1.2	184	75	258	238	
Q5	382	71	45	273	1.7	1.3	193	71	317	284	***

*Note: ‘n’ is the number of observation, ‘s.d.’ is the standard deviation. ‘sign. Diff.?’ refers to the significant difference in mean value of the outcome specified in the one but last column between households in different regions, farm size quintals or asset value quintals. These are obtained from the regression of the outcome variable on the region dummy, farm size quintals and asset value quintals; where the first dummy is taken as reference. Q1 to Q5 refer to the first to fifth quintal, South and N&C respectively refer to south Tanzania and central and north Tanzania. The stars refer to the level of significance: *p<0.10, **p<0.05, ***p<0.01, no star: insignificant difference, n.a. means not applicable.*

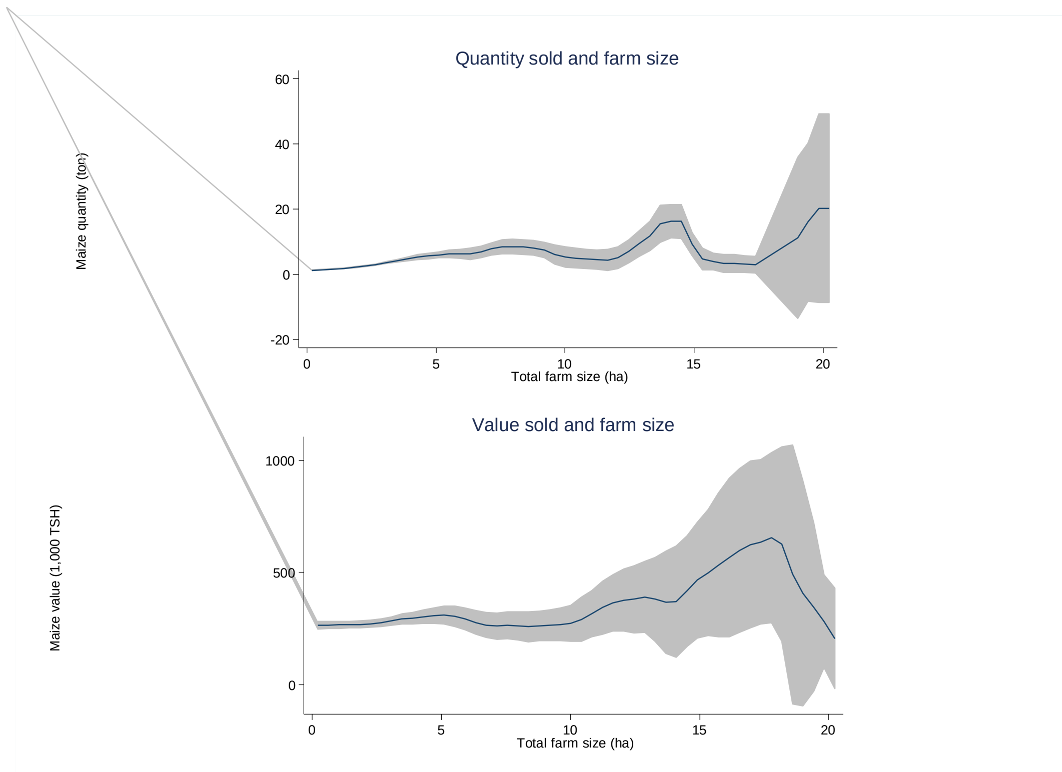


Figure 14-21: non-parametric graph of maize sales quantity and value in function of farm size.

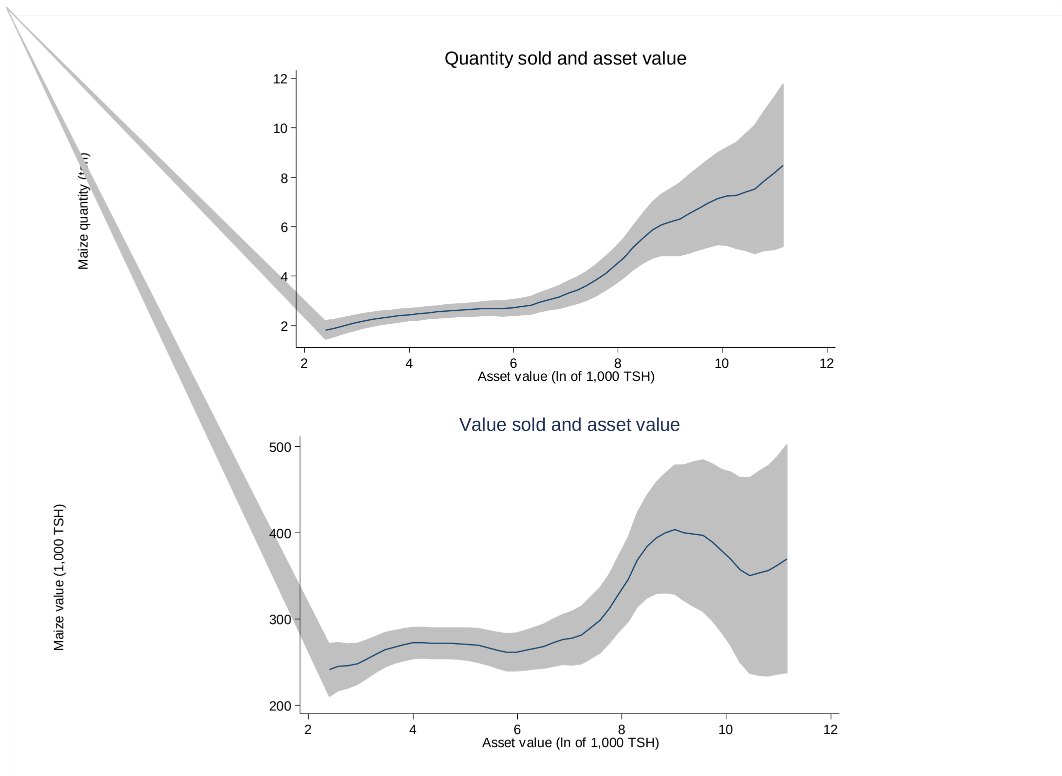


Figure 14-22: Non-parametric graph of maize sales quantity and value in function of asset value

Table 14-29 displays the characteristics of the first maize transaction reported by farmers, which should be the transaction with the largest quantity of maize sold. Most of these transactions occurred within the village (83%), and only 5% of the maize was sold at the farm gate (results not reported). Almost none of the maize selling farmers report to be in a contract farming arrangement for their largest maize transaction. Finally, Figure 14-23 shows to whom farmers sell. The large majority of farmers (61%) sells maize to middlemen. Other maize buyers that are less frequently used are wholesalers (12%), large traders (10%) and other cooperative members (9%). Only 2% of the farmers sold their maize to the farm cooperative.

Table 14-30: Maize marketing characteristics of first (and largest) transaction

First maize transaction	N	Mean	s.d.	Median	Min	Max
Household sold maize (%)	1,885	64	48	100	0	100
Number of maize transactions	1,220	1.0	0.2	1	1	3
Person to decide on maize sales was male (%)	1,220	84	37	100	0	100
Maize was sold in the village (%)	1,220	83	37	100	0	100
Household was in contract farming (%)	1,220	1.6	12	0	0	100

Note: ‘n’ is the number of observation, ‘s.d.’ is the standard deviation,’min’ is minimum, ‘max’ is maximum

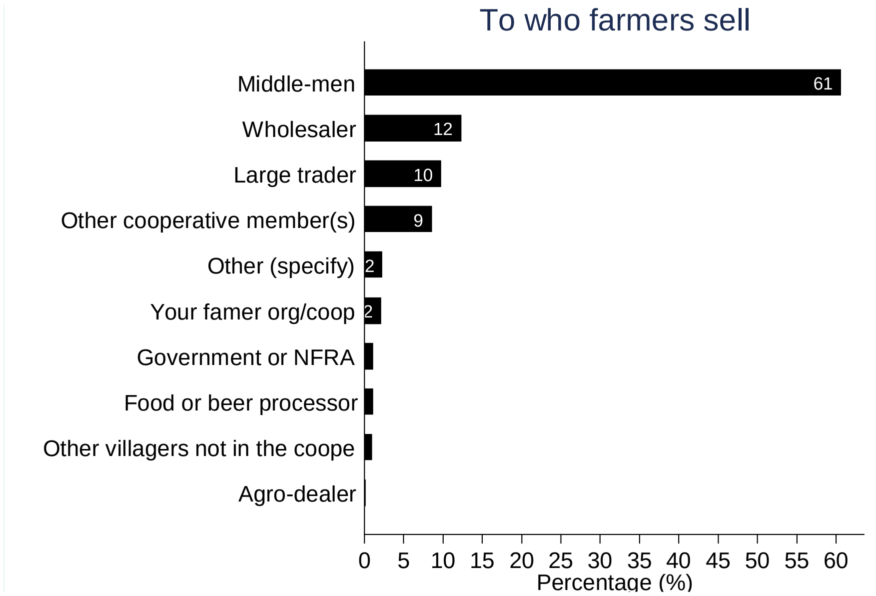


Figure 14-23: Buyers of maize

Finally, Figure 14-24 displays the reason why households were not selling maize. The main reason for not selling maize is because households use the maize for consumption (42%) or there was just not enough maize to sell (41%). Similarly, we asked the maize selling farmers whether they were able to sell as much maize as they envisioned. 25% of the maize selling farmers indicated that they were not able to sell more maize, and mainly because there was not enough maize to sell (45%) or because the maize price was too low at the time of harvest (26%) (results not reported).

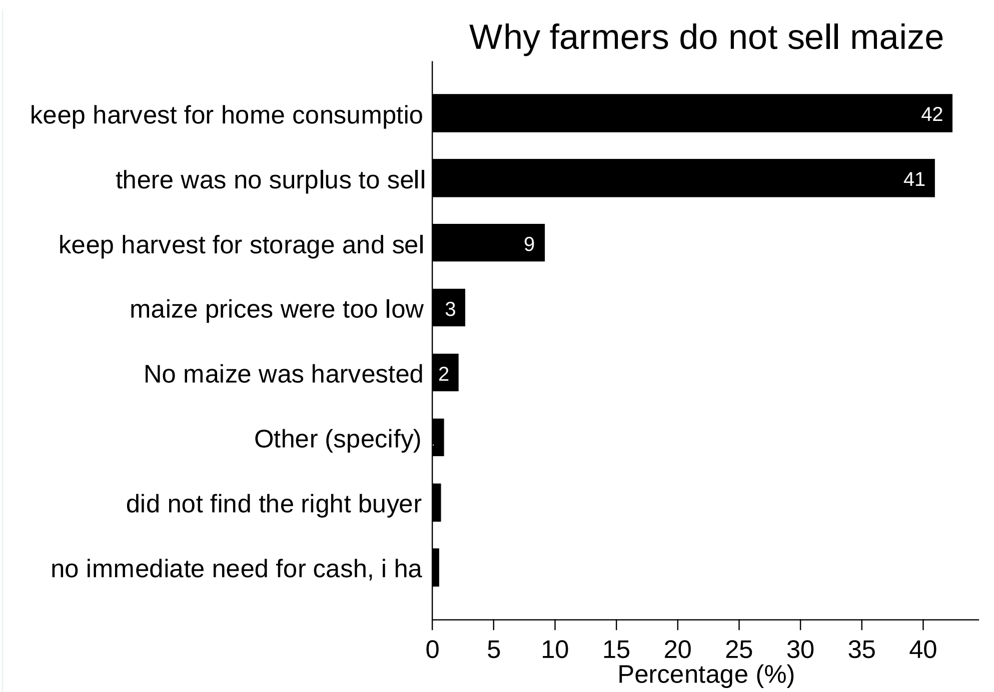


Figure 14-24: Reasons why do farmers not sell maize

14.5 Household livelihood strategies

14.5.1 Employment

Table 14-31 reports the characteristics of the non-farm enterprises operated or owned by the household. 25% of the households have anyone within the household that operated a non-farm labor enterprise in the last 12 months.[36] 3% of the households have a household member that stopped operating a non-farm labor enterprise in the last year, mainly because the enterprise went bankrupt or was not profitable. Table 14-31 summarizes some statistics for the biggest non-farm labor enterprise for those households that operate at least one. 98% of the households with a non-farm enterprise have only 1 operation. On average, only 1 household and non-household member are active in the enterprise. On average, the enterprises are 9 years active since startup, and they operate on average 10 months per year. The gross income of the enterprise during the last month was 305 USD, and after deducting the operational costs, the net income is 80 USD. Figure 14-25 shows that households use own savings (44%) or income from other agricultural business (30%) as startup capital for the biggest non-farm labor enterprise.

Table 14-31: Non-farm enterprise characteristics and income

Characteristics of the non-farm enterprise (N=484)	Mean	St. Dev.	Median	Min	Max
Non-farm enterprises owned by the household (number)	1	0.3	1	1	3
Household members active in biggest enterprise (number)	1	1	1	1	12
Non-household members active in biggest enterprise (number)	1	1	0	0	15
Gross income of biggest enterprise last month (USD)	305	551	138	5	3,910
Net income of biggest enterprise last month (USD)	80	105	46	1	690
Average net monthly income of biggest enterprise (USD)	339	651	83	2	4,416
Months that biggest enterprise was active (number)	10	3	12	1	12
Average net yearly income of biggest enterprise (USD)	3,557	6,854	773	6	41,842
Years operating since startup (number)	9	7	6	1	48

Note: ‘n’ is the number of observation, ‘s.d.’ is the standard deviation, ‘min’ is minimum, ‘max’ is maximum

[36] Non-farm enterprises are defined as a household member having any non-agricultural income-generating enterprise that produces goods or services or has anyone in your household owned a shop or operated a trading business.

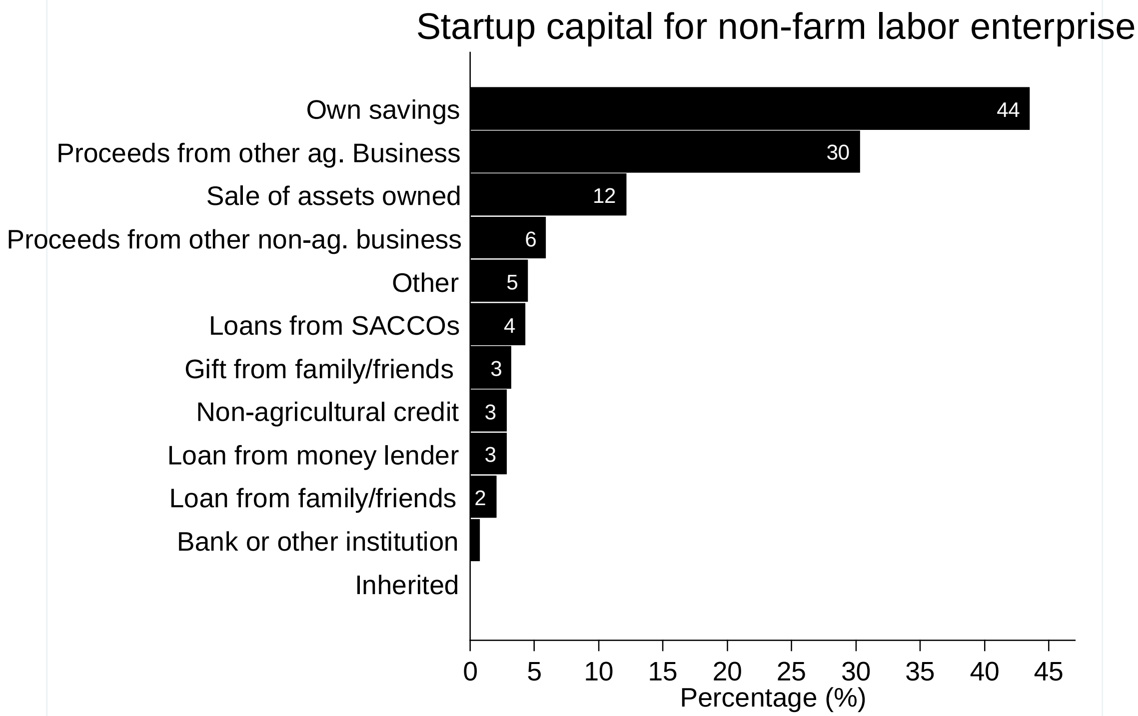


Figure 14-25: Source of start-up capital for non-farm labor enterprise

14.5.2 Credit and labor constraints

We are further interested in understanding whether and when households are credit constrained. Therefore, we asked household heads whether the household would be able to raise an additional amount of 50,000 TSH (23 USD) a week before and after harvest, and how they would do so. Table 14-32 (Figure 14-26) below summarizes the results. Before harvest, 75% of the households would be (hypothetically) able to raise 50,000 TSH a week before harvest. This extra money would come from using household savings (36%), taking on extra work within the village (20%) or either selling corps (15%) or livestock (15%). A week after harvest, 91% of the households would be able to raise the same amount of 50,000 TSH, which is an increase of 16 percentage points. More than half of the households would do so by selling crops (55%) or to a smaller extent by using savings (20%) or taking up extra work.

Table 14-32: Can households raise additional 50,000 TSH a week before or after harvest?

		… before harvest			**… after harvest**		
		N	mean	s.d.	N	mean	s.d.
Household can raise 50,000 TSH 1 week…		1,933	75	44	1,933	91	29
How would it be done?	By selling stocks or crops	1,441	15	36	1,759	55	50
	By selling livestock	1,441	15	36	1,759	9	28
	Using savings	1,441	36	48	1,759	20	40
	Ask for help from relatives within village	1,441	9	29	1,759	2	14

Take extra work within village	1,441	20	40	1,759	13	34
Other	1,441	5	21	1,759	2	13

Note: 'n' is the number of observation, 's.d.' is the standard deviation

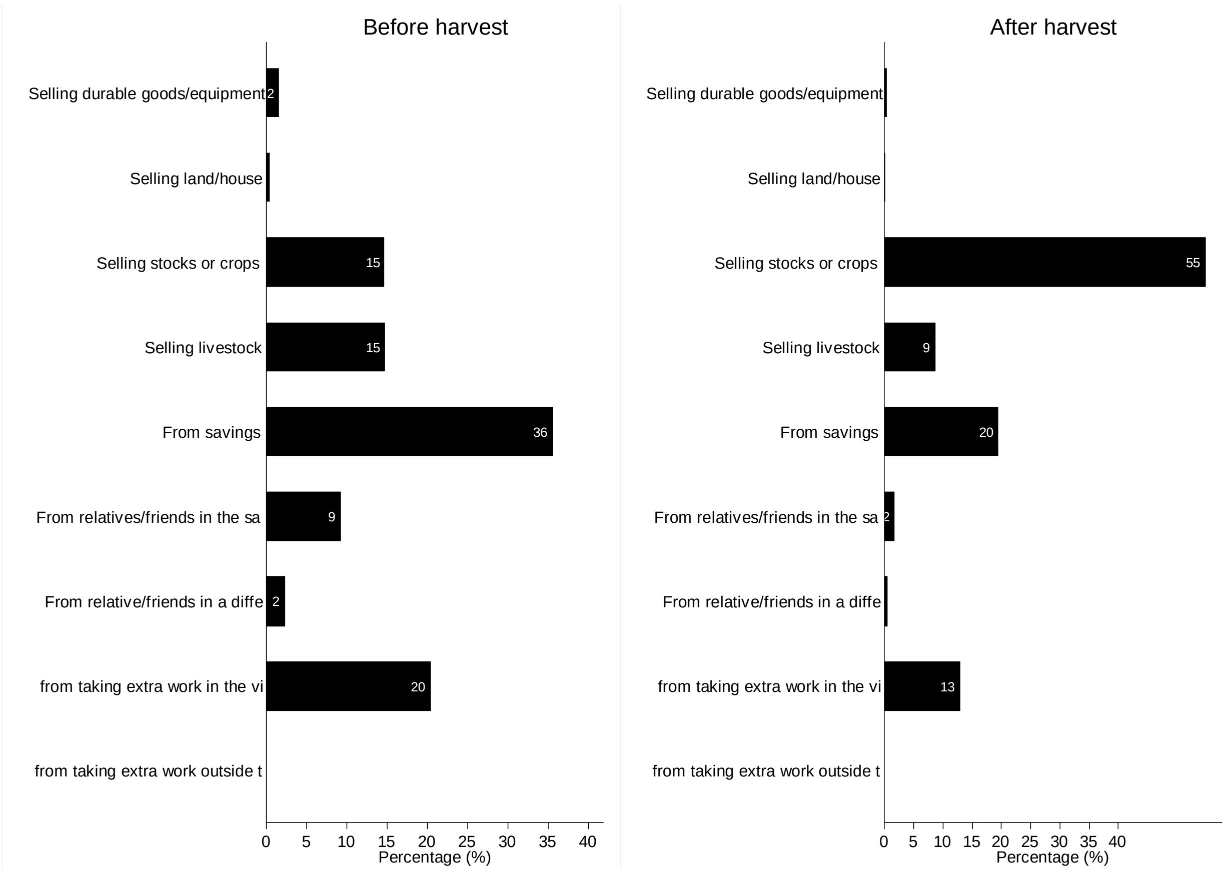


Figure 14-26: If households were able to raise 50,000 TSH, how would they do so?

Similarly, we are interested in understanding whether households are constrained in supplying more labor on their farms. We asked a set of similar questions to household heads whether they would be able to hire additional labor for land preparation and sowing, weeding, and harvesting. Then, we asked how they would do it, and if they would use extra household labor, what they would do less. Table 14-33 reports shows that more than four out of five households would be able to hire additional labor for the farming activities specified. The large majority would do so by hiring in more labor, and to a smaller extent by using more labor from household or family members. Those that use extra household labor would not necessarily spend less time on other crops or non-farm activities, as the majority of the households indicate they would do nothing less.

Table 14-33: Would households be able to find more labor if needed

	… land preparation and sowing			… weeding			… harvesting		
	N	mean	s.d.	N	mean	s.d.	N	mean	s.d.
Household could hire additional labor for …	1,933	85	36	1,933	84	37	1,933	85	36
Use more household labor	1,639	10	30	1,625	8	27	1,644	8	27

How would it be done?	Use more family labor that is not in the household	1,639	9	29	1,625	10	30	1,644	10	31
	Ask neighbors to help without compensation	1,639	4	19	1,625	4	19	1,644	4	20
	Share labor with neighbors	1,639	6	23	1,625	6	23	1,644	6	24
	Hire in more labor	1,639	71	45	1,625	73	44	1,644	72	45
	Other	1,639	0.1	2	1,625	0	0	1,644	0	5
If household labor, what would you do less?	Nothing	165	50	50	128	59	49	125	62	49
	Cultivate less of other crops than maize	165	22	41	128	14	35	125	15	36
	Participate less of nonagricultural activities	165	27	44	128	26	44	125	22	41
	Other	165	2	13	128	1	9	125	2	13

Note: 'n' is the number of observation, 's.d.' is the standard deviation

14.6 Beliefs and preferences

14.6.1 Which adverse weather shocks are farmers worried about?

Firstly, we ask which adverse weather shocks the farmers think are most likely to occur and would negatively impact their crops. More specifically, we ask each farmer to list the first and second most likely adverse weather shocks to occur from the following list:

7. There will not be sufficient rain during the normal planting time, and planting will be delayed at least 30 days.
8. There will be a day (or several subsequent days) where there is too much rain during the production of maize, and the maize plot will be flooded.
9. There will be a drought on the maize plot, meaning that there will be not be enough rain during several days of the maize production.
10. There will be hail during the production of maize that will destroy the maize.
11. There will be a period where the temperature is too high (above 30 degrees) that will destroy the maize.
12. There will be pests (insects, animals, weeds, etc.) that destroy the maize output on the plot.

Figure 14-27 shows the distribution of the average farmers' beliefs. In particular, it illustrates that farmers view the prospect that "There will not be sufficient rain during the normal planting time, and planting will be delayed at least 30 days." as being by far the most likely adverse weather shock to occur. Drought was the shock that farmers viewed as second most likely to occur.

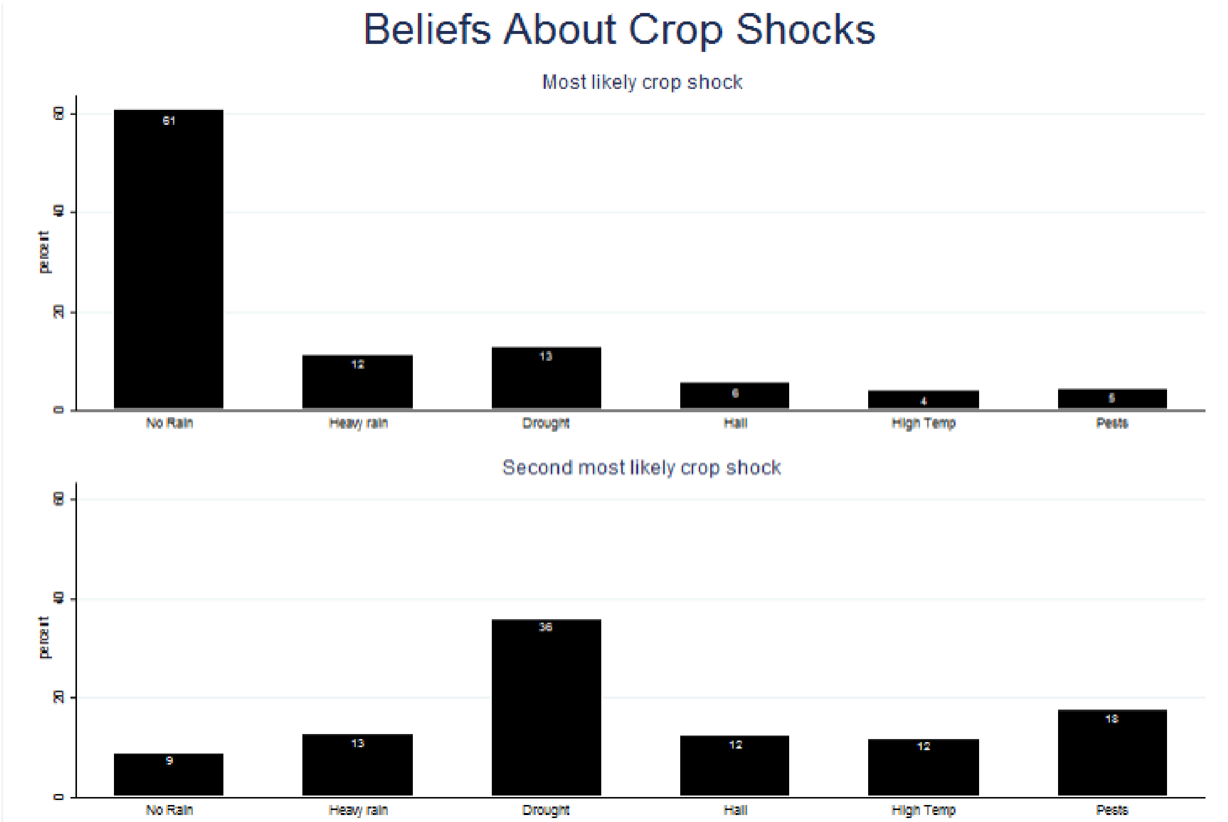


Figure 14-27: Farmers' beliefs about shocks occurring to crop production

14.6.2 What are farmers' beliefs over the distribution of expected rainfall?

The following section asks whether there are any observed patterns in the farmers' expectations regarding the rainfall in the next year. In particular, we elicited the distribution of farmers' beliefs regarding the likelihood of rainfall in the coming season on a 5 point scale – i.e. being "much below normal", "somewhat below normal", "normal", "somewhat above normal", "much above normal".

Figure 14-28 displays the average expectations of farmers in the entire sample regarding the likely rainfall in the next growing season. We see that the modal response was for farmers to expect "normal" rainfall in the next growing season. Approximately a third of farmers gave this response. However, there was substantial heterogeneity in answering this question. Perhaps, the most noteworthy feature of Figure 14-28 is that a greater share of farmers were pessimistic regarding the rainfall prospects in the coming year, in comparison to the share that were optimistic. In particular, around 45% reported that they expected rainfall to be "much below normal" or "somewhat below normal", while only 21% reported rainfall to be "much above normal" or "somewhat above normal". This implies that the farmers view rainfall risk as being skewed in the negative direction, with more downside risk than upside risk (of course, it is important to keep in mind that expected yields are not monotonically increasing in rainfall, and extremely high rainfall levels are also a negative outcome from the perspective of farmers).

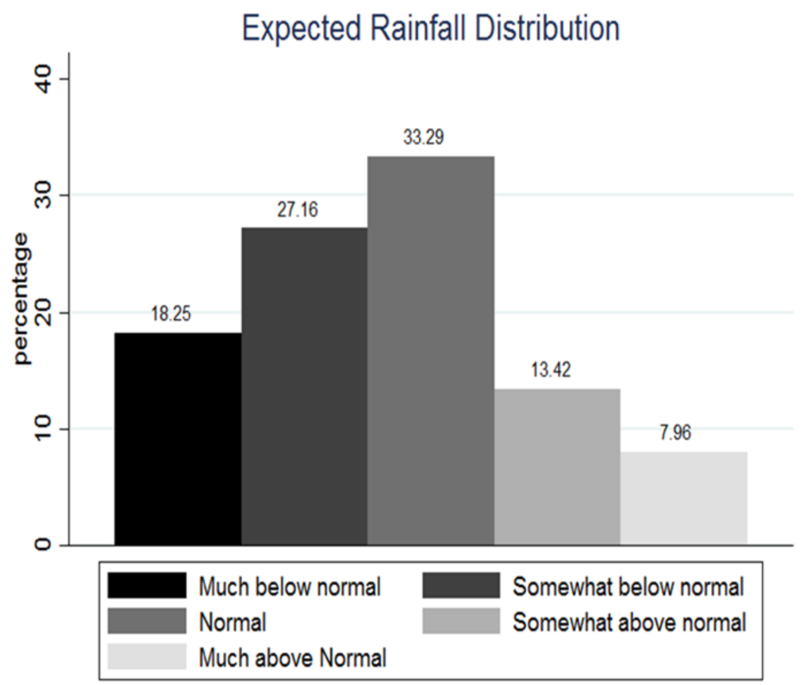


Figure 14-28: Distribution of the rainfall expected in the next growing season

Having considered the beliefs of the average farmer in the sampled population as a whole, we now shift attention to considering how these beliefs differ by region. In particular, we disaggregate the beliefs above into the two subsamples in the South and Central / Northern regions. This allows us to compare the beliefs held in these different regions, and also to compare these belief differences to observed differences in actual realized yields between the two regions.

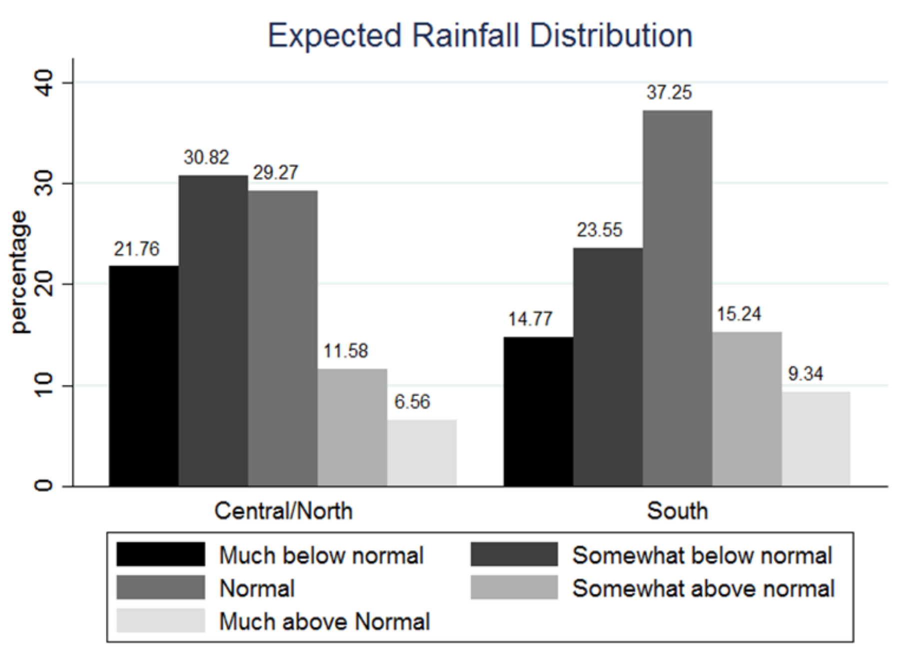


Figure 14-29: Distribution of next season expected rainfall disaggregated over region

Figure 14-29 shows that farmers in the South are more optimistic regarding the expected rainfall in the coming growing season (we see first order stochastic dominance). Slightly more than 50% of farmers in the Central / Northern regions expect rainfall to be “much below normal” or “somewhat below normal”, while fewer than 40% in the South hold this negative belief.

14.6.3 What are farmers’ beliefs about the likely crop yields?

One of the main outcomes of interest is the yield realized by these farmers. As mentioned above, there are many factors that play a role in the production process and impact the realized yield, including: weather conditions, knowledge and expertise of the farmers, inputs used, soil conditions, and the interaction between these afore-mentioned factors. In this section, we focus on the farmers beliefs regarding the likely yield that will be realized on their plot in the coming year. In particular, we try to assess how two factors will shift the distribution of possible yields. First, we consider how the weather will shift the expected distribution of yields. Second, we consider how the choice of inputs will affect the expected distribution of yields.

This approach is seen in Figure 14-30, which is split into six panels. Each of the three left-hand panels report the farmers' beliefs about the distribution of possible yields, if they were to use exactly the same inputs as they used in the previous year. The three right-hand panel report the farmers' corresponding beliefs using the best inputs for the land as per the recommendation of the extension provider. Therefore, the left-to-right panel comparisons essentially provide a comparison of using different inputs, holding all else equal.

Now, instead moving down the left-hand column of panels, Figure 14-30 considers the farmers beliefs under the same inputs as last year, while varying the weather conditions. More specifically, the top-left panel considers the expected yield distribution under “bad weather”, while the middle-left panel considers the expected yield distribution under “normal weather” and the bottom-left panel considers the expected yield distribution under “good weather”. As mentioned above, the right-hand panels report the same, but for optimal inputs.

The results are very interesting. Firstly, it is clear from Figure 14-30 that the farmers expect the weather to play a huge role in influencing the distribution of yields they expect. For example, using the same inputs as last year, the average farmer expects that the probability of the yield being 4 or fewer bags per acre decreases from 41% to 17% to 9% as the weather goes from “bad” to “normal” to “good”. Similarly, the belief regarding the probability of a yield of at least 16 bags per acre increases from 6% to 13% to 29% over the same change in weather. Notice that shifting from “bad” to “normal” weather has a larger impact on the belief about the worst outcome, while shifting from “normal” to “good” weather has a larger impact on the belief about the best outcome.

Now, comparing the distributions that have the same weather, but differ in terms of inputs (i.e. within each row), we see that farmers expect the inputs used to play a role, since the distribution shifts to the right towards a higher probability of better outcomes when using the recommended inputs. However, it is interesting to note that the farmers view the change in inputs to play a smaller role than the change in the weather. The distributions change less moving from left to right, than they change moving downwards within a column. More work should be done here in comparing these expected conditional distributions with the actual realized distributions, and how the realized distributions change as a function of the weather and the inputs used.

Having considered the beliefs regarding the distribution of yields in the population as a whole, we now compare the beliefs of farmers in the South with those in the North / Central regions. Here, we only look at the beliefs under the same inputs as last year. Therefore, the rows again differ in terms of weather conditions, while the columns now refer to either the “South” or the “North / Central” regions.

The main story illustrated by Figure 14-31 is that farmers in the South have far better expectations regarding the likely yields they will have. This is highlighted by the fact that the expected distribution of yields under Bad Weather in the South is almost the same as the expected distribution of yields under Normal weather in the North / Central regions.

Therefore, at least in terms of their beliefs, the returns to growing maize are far higher in the South. In addition, Figure 14-31 illustrates that “bad weather” is believed to generate extremely bad outcomes in the North and Central regions (high downside risk).

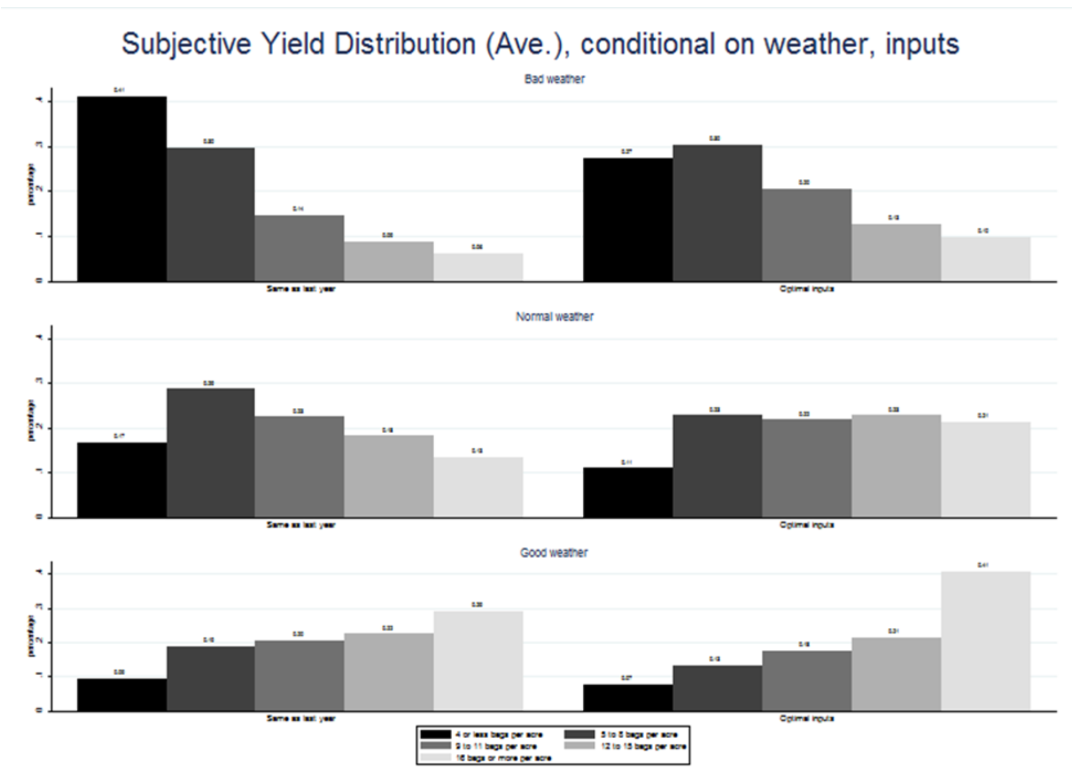


Figure 14-30: Distribution of subjective maize yield expectation, conditional of weather outcome and input application

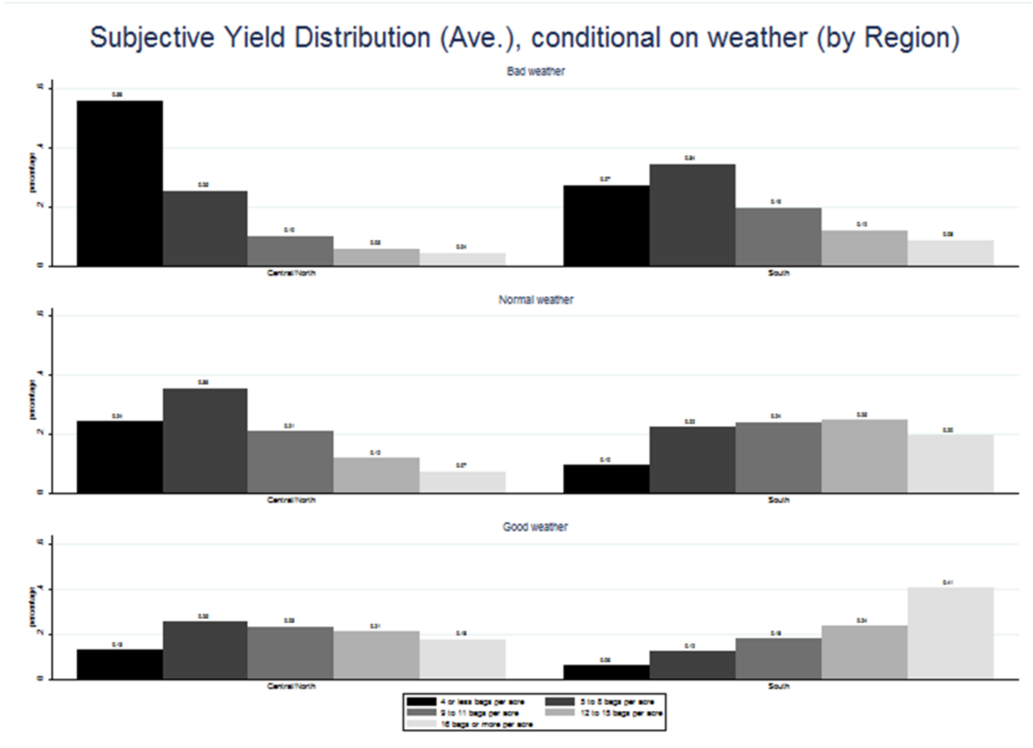


Figure 14-31: Distribution of subjective maize yield expectation, conditional of weather outcome and input application; disaggregated over regions.

14.6.4 Farmers' Trust and Reliance on Others

Lastly, we consider how much the farmers trust other individuals who are important for the successful production and sale of their crops. This is extremely important for smallholder farmers as they rely so heavily on a large number of other individuals in order to complete the cycle of acquiring inputs, and then growing and selling their crops. Furthermore, there are potentially large complementarities and benefits of scale to grouping together as a collective and reducing the costs of things like storage, transport and negotiating deals.

However, many of these benefits of collaboration are only realized if there is a sufficient amount of trust, and if this trust is warranted. If farmers do not trust the sellers of new inputs and technologies, they may be unwilling to expend resources on trying them. If farmers do not trust the leader and member of their FO, then the FO may not function effectively and several of the economies of scale may be eroded.

The graphs in Figure 14-32 try to assess the farmers' degree of trust in one another. The first graph asks farmers to rate the degree to which they trust: (i) the FO leader, (ii) another member of the FO, (iii) the maize buyer. The question is asked on a scale of 1 to 10, where 1 indicates "I don't trust this person at all" and 10 indicates, "I trust this person completely".

In relative terms, the farmers tend to trust the FO leader the most, another member of the FO a little less, and the maize buyer even less. The modal response was 10 for the FO leader, and 5 for each of the others (however, more of the density was placed on high numbers for the FO member than for the maize buyer).

In a similar vein, we asked how much farmers felt they could rely on people to perform the task or function they needed to perform in order for the farmer to succeed. In particular, we asked about the farmers beliefs about how much they felt they could rely on: (i) the fertilizer supplier to deliver the correct about of fertilizer, (ii) the output buyer to arrive at the correct time, (iii) the seed supplier to not give poor quality / fake seeds.

The average farmer appeared to have an intermediate degree of trust in the reliability of the fertilizer supplier, and the output buyer to do their jobs well, with the modal response being 5. However, farmers appeared to be skeptical regarding the reliability of the seed supplier, with the modal response being 1 or "not at all" for the seed supplier. This suggests a high degree of mistrust on behalf of the farmers when it comes to the supply of new seeds. This lack of trust in the seed supplier to not provide fake seeds could explain a reluctance on the part of farmers to participate in programmes that aim to provide them with new / better seeds, even if they believe that they could be effective. Therefore, any attempt to shift farmers towards adopting different seeds would first need to address this lack of trust in order to be effective in shifting the farmers' behavior.

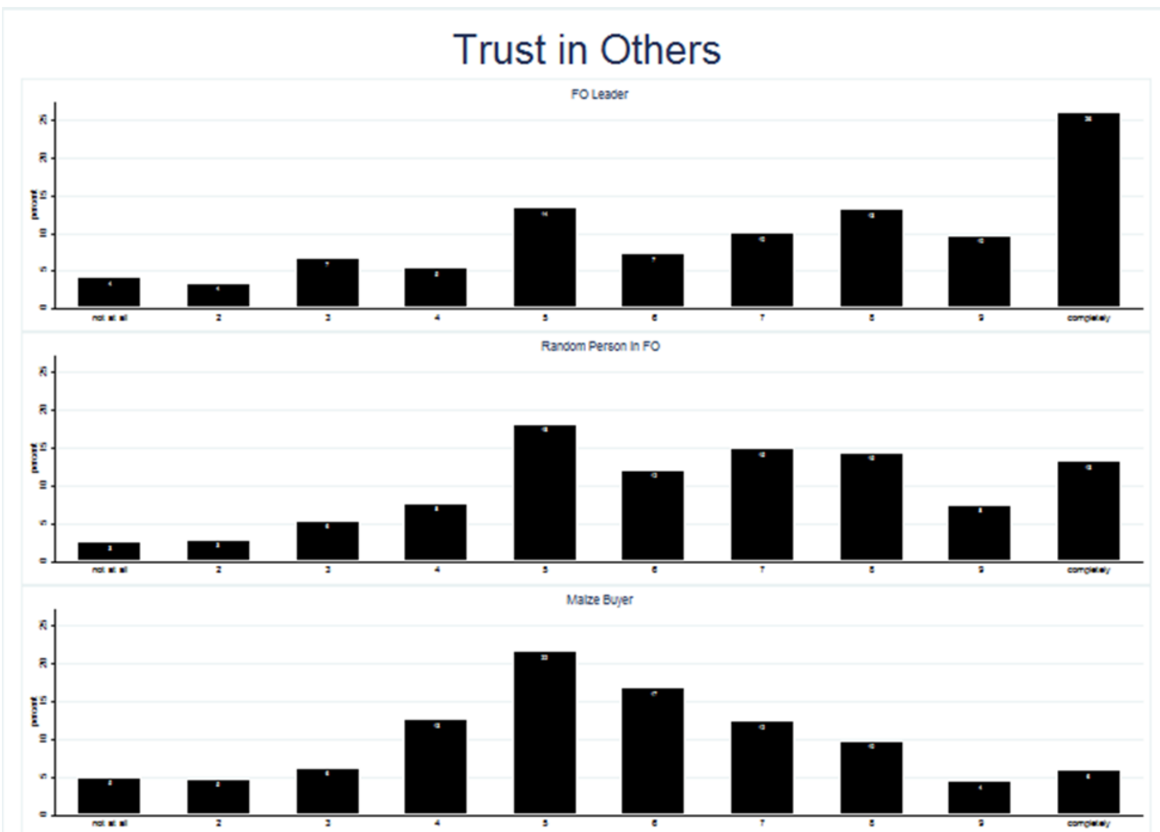


Figure 14-32: Trust in other persons