Costs and benefits of climate-smart agriculture practices

Evidence from intercropping and crop rotation of maize with soybean in rural Tanzania

Working Paper No. 306

CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS)

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Abstract

Climate change will adversely affect agricultural production for small-scale farmers in developing countries. Many policy initiatives advise the use of climate-smart agriculture (CSA) practices to improve the adaptation of the farmers to the climate and reduce the adverse impacts of climate on agricultural production. Among others, the profitability of investing in agricultural practices is a significant factor that influences the adoption of agricultural practices among farmers in developing countries. Are CSA practices profitable for small-scale farmers in developing countries? We address this question by investigating the profitability of CSA practices in rural Tanzania. We conduct a cost-benefit analysis (CBA) in Iringa rural district in Tanzania for four CSA practices involving crop rotation or intercropping maize with early or late-maturing soybean varieties. Our findings show that CSA practices are financially profitable for those farmers. Investments in crop-rotation practices have higher net present values, internal rates of returns, and shorter payback periods when compared to intercropping. We do not find any differences in the profitability of early and late maturing seeds. Our robustness checks show that almost all our study population can make a profit from investing in those practices. However, the profitability of those practices depends on market interest rates (discount rates), labor cost, and maize prices. These findings imply that investments in CSA practices, such as crop rotation and intercropping of maize with soybean, have positive returns in short periods. These short payback periods make crop rotation with soybean a profitable investment option for small-scale farmers in rural areas with limited financial power. Policymakers can support the use of CSA practices and design instruments to upscale the adoption of those practices, especially in rural Tanzania and in similar contexts.

Keywords

Climate-smart agriculture; Intercropping; Crop rotation; Profitability; Technology adoption; Smallholder farmers

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Contents

1. Introduction

Climate change increases the agricultural income losses of 500 million small-scale farming households in developing countries, reducing their food security (Beddington et al., 2012; Lipper et al., 2014; Viller and von Braun, 2013). To reduce the losses, climate-smart agriculture (CSA) approach promotes agricultural practices with three main characteristics: increasing agricultural productivity, enhancing the resilience of farmers to climate change, and, where possible, mitigating greenhouse gas emissions from agriculture (FAO, 2013). Upscaling the adoption of those practices is essential to improve the resilience and livelihood of farmers in developing countries. The use of agricultural practices by small-scale farming households depends on various factors such as imperfections in credit markets (Croppenstedt et al., 2003), learning, and networks (Conley and Udry, 2010; Maertens and Barret, 2013) and behavioral factors (Kremer et al. (2011). Among those factors, economic returns and profitability of those practices is a significant factor that explains the low adoption of the practices.

Are CSA practices profitable for small-scale farmers in developing countries for the uptake? To contribute to the answer to this question, we use costs and benefits analysis (CBA) and investigate the profitability of CSA practices for small-scale farmers in rural Tanzania. Both current and projected climate information for Tanzania shows a trend of increasing temperatures (+0.5°C since 1980, +1.7°C by 2050) and decreasing rainfall, as well as a higher variability of extreme climatic events such as droughts and floods (CIAT and World Bank, 2017; CIAT and CARE Tanzania, 2019). Some estimates indicate that climate change will increase temperatures up to four degrees Celsius and decrease rainfall decrease by up to 12% in Tanzania until 2100 (The United Republic of Tanzania, 2015). Increases in temperatures and reductions in rainfalls will reduce agricultural production in Tanzania (representing 25% of the country's economy as of 2018) by about 10% (The United Republic of Tanzania, 2014), leading to deterioration in food security in the country (Arndt et al., 2012).

To build more resilient and sustainable agricultural systems, the Tanzanian government has already announced several national policy initiatives[1]. Those policy initiatives propose to use climate-smart agriculture (CSA) practices to mitigate the adverse effects of climate change on agricultural production. CSA practices aim to enhance agricultural productivity, improve the resilience of farmers to climate change, and, where possible, mitigate greenhouse gas emissions from agriculture. The National CSA profile and the National CSA Guideline have identified a range of CSA practices that farmers can apply in their contexts. Examples of those CSA practices are the use of drought-tolerant, high yielding, or early maturing varieties, integrated soil fertility management via the use of compost and manure, water resource management through sustainable irrigation or rainwater harvesting, minimum tillage, cover crops, intercropping, and crop rotation. While those reports highlight the importance of taking CSA into account in national or regional development policies, not much is known about the economic viability of the CSA practices within the local context in Tanzania. Learning and informing about the profitability of those practices will improve the adoption rates of those practices by small-scale farmers in Tanzania.

Previous studies use cost-benefit analysis (CBA) model to assess the profitability of projects, programs, and policies both in the private and public sector (Boardman, 2014) and help them in the allocation of scarce resources more efficiently (Claus and Rousseau, 2012). More specifically, CBA shows whether an investment option is of superior performance (efficiency) compared to the status quo (i.e., business as usual)[2]. Two types of CBAs are commonly used; ex-ante and ex-post CBA. Researchers use ex-ante CBA when the practice in question is under consideration for investment purposes, and ex-post evaluation is conducted at the end of practice (i.e., when all the cost has been sunk). CBA has also been used to assess the

[1] Those initiatives are summarized in the reports and development frameworks of the National Adaptation Program (NAPA) and 2007, the National Climate Change Strategy (NCCS) of 2012, the Agriculture Climate Resilience Plan (ACRP) of 2014, the Climate Smart Agriculture Guidelines and the CSA Profile of 2017

[2] Two types of CBA are commonly used; ex-ante and ex-post CBA. Ex-ante CBA is used when the practice in question is under consideration for investment purposes while ex-post evaluation is conducted at the end of practice (i.e. when all the cost has been sunk) The ex-ante is important particularly for making decisions about how resources can be allocated, and whether or not to continue with the implementation of practice or project (Boardman, 2014).

viability of agricultural practices under climate change (Daigneault et al., 2016), the cost-effectiveness of climate-smart soil practices (Ng'ang'a et al., 2017b), the viability of climate-smart agricultural practices (Ng'ang'a et al., 2017a), and cost-benefit analysis of fodder as a low emission (Kashangaki and Ericksen, 2018).

In the study, we use a project implemented by CARE in Tanzania that introduces climate-smart practices to farmers in the Iringa district as a case study to investigate the costs and benefits. First, we conduct a workshop with farmers participating in the projects and interview key experts to identify the critical CSA practices introduced by the project. Then we use secondary data sources (e.g., exports, district profiles) and collect detailed cost and yield data from the farmers that have already adopted those practices to conduct an ex-post CBA.

Workshops with farmers and key expert interviews reveal that crop rotation and intercropping of maize with early or late-maturing soybean varieties are the most beneficial and relevant CSA practices in the region. Crop rotation and intercropping practices have the potential to reduce weeds, pests, and diseases. Soybean will fix nitrogen in the soil, which will improve productivity and reduce the need for the use of inorganic fertilizer, and contribute to the reduction of nitrogen emission (FAO, 2014). Moreover, it is expected that early-maturing soybean varieties might improve the adaptation of farmers to short rainy seasons.

Our CBA estimates show that investment in these practices become profitable in two to seven years. Investment in crop rotation of maize with soybean varieties have higher returns on investment and the shorter payback period when compared to intercropping of maize with soybean. This is mainly caused by the low installation, maintenance, and operational costs of the crop rotation practices. Farmers also expect that crop rotation will provide maximum yield from maize and soybean faster than intercropping. We, however, do not detect a difference in the returns to adopting early or late-maturing beans. These results imply that upscaling the adoption of intercropping and crop rotation of legumes with maize will be both financially beneficial to the farmers. However, farmers will realize the financial benefits of the inter-cropping later than crop rotation.

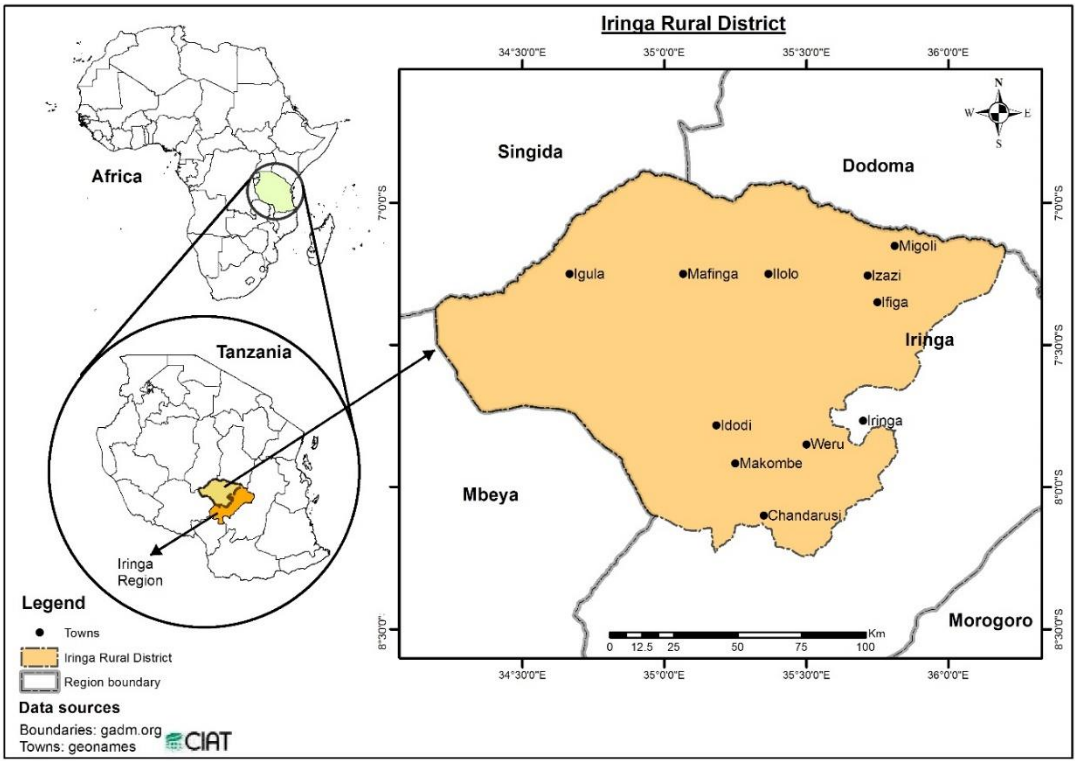
Next, we test the robustness of our results. For this purpose, we first analyze the risk of experiencing a loss from investing in those practices, and then, the sensitivity of our results to changes in farmers' discount rates, input and labor costs, yields, and prices. We find that the risk of a loss from investing in all four practices is very low. However, the profitability of these practices depends on the farmers' discount rates (e.g., market interest rates), labor costs, soybean yields, and maize prices. Robustness checks have two main conclusions. The profitability of the practices decreases by the increases in the discount rates (e.g., interest rates) of farmers. The profitability of intercropping practices converges to the profitability of crop rotation when labor costs are reduced, and maize prices are increased.

The study is organized as follows. Section 2 introduces the study site. Section 3 explains the process to identify the CSA practices, and section 4 explains the CBA model. Section 5 introduces the data used in this study. Section 6 summarizes the findings from CBA for the CSA practices in the study site, and section 7 concludes with a discussion on policy outcomes of the study.

2. Study site

This study focuses on the Iringa Rural district of Iringa region shown in Figure 1.

Figure 1: The study area



The district is located in the Southern Highlands of Tanzania. Iringa rural district covers an area of 20,414 km^2 and shares a border with the Kilolo district to the East and Mufindi district to the South. In the North, the district is bordered by the Dodoma region, while to the West, it borders the Mbeya region. Altitude ranges from 800 to 1800 meters above sea level, and the district receives between 500 and 1000mm of rainfall annually. The colder rainy season from November to April is the primary growing season, while the dry season lasts from May to October.

Upscaling the adoption of those practices in the Iringa region of Tanzania has recently become a priority, as climate change will have adverse effects on the livelihoods of the rural agricultural producers of the area. In the Iringa Rural district, agriculture's role as a source of both food and income is even more preponderant than the overall Tanzanian economy, as the sector contributes to 99% of the district's GDP (Iringa Rural socio-economic profile, 2013). With its diverse landscape, the region is highly suitable for a diversity of crops that are cultivated during the primary growing season, between November and April. Agriculture is mostly rainfed, with only 16% of farming households using irrigation, and relies mainly on small-scale subsistence farming. The principal food crops are maize, rice paddy, Irish potato, and beans and constitute the core of food consumption in Iringa. Sunflower, tomato, groundnuts, and onions are the main cash crops cultivated in the region. They account for approximately a fifth of the whole cultivated land, and a tenth of the total production in tons. (CIAT and CARE-Tanzania (2019).

Farmers in the region have already perceived the effects of climate change through increases in temperature, higher climate variability, and shortening of the rainy season, thereby decreasing crop yields (CIAT and CARE-Tanzania, 2019). 73% of households are small-scale agricultural producers with low-income levels, depending on farming for their livelihoods. Those farmers are vulnerable to climate change, lacking knowledge and resources to invest in expensive CSA practices.

Our study focuses on Kukua ni Kujifunza (KnK), an agriculture project implemented by CARE-Tanzania in Iringa. KnK project has been introducing CSA practices and droughtresilient soya crops to the small-scale farmers in 15 villages in Iringa since 2018 through existing Farmer Field Business Schools (FFBSs) and Village Savings and Loan Associations (VSLAs). All the villages of the KnK project are in the midlands, a zone of scattered mountain hills and plateau ranging from 1400 to 2200m of altitude. This agro-ecological region is characterized by high rainfall levels (600-1000mm) and low temperatures (15-20°C) when compared to the semi-arid plains of the lowlands (Iringa Socio-Economic Profile, 2013).[3]

3. Identification of CSA practices

We conducted one focus group discussion (FGD) and seven key expert interviews. The FGDs comprised of one man and nine women from the study region. Interviews were with regional stakeholders from the Iringa district council members, extension agents in charge of implementing the KnK project, and paraprofessional farmers responsible for the coordination of the project in villages. The selection of crucial CSA practices, identification, and ranking of the practices introduced by KnK and taught in the FFBSs that were more relevant to the farmers was made jointly by FGD and the experts. From the expert interviews, we learned practices that farmers used as an adaptation strategy to climate change in the region.

FGDs showed that the farmers rank crop rotation of maize and soybean first. This is because implementing crop rotation requires less labor effort and small investment and provides good yields. Farmers ranked organic fertilizers such as cow manure and compost as second for improving soil fertility. Few farmers can, however, adopt organic fertilizers. Due to inadequate access to cow dung and low compost quantities, farmers rarely produce organic fertilizer enough to fertilize the cropped area. Inorganic fertilizers give good results with maize but are costly.

[3] Until now the project has conducted climate vulnerability and capacity assessment, climate risk profiling, and market potential studies out in the region to learn which CSA practices might be viable. It has also trained farmers in crop-rotation and intercropping with soya with maize, inorganic fertilizer and minimum tillage applications in the FFBSs.

Furthermore, applying inorganic nitrogen on soybean crops cancels the nitrogen fixating capacity of soybean. Intercropping was ranked third because of its benefits in terms of diversification of the crops. Nevertheless, farmers highlighted that the competition between plants resulted in lower yields when they use intercropping. The minimum tillage ranked last. It has only been tested on the experimental plots in FFBSs and proved to be inefficient in terms of its ability to regulate weeds. Consequently, it has never been implemented by farmers in their fields. As a result, we concluded that crop rotation and intercropping of maize with soybean were the most widely accepted and applicable practices in the study region that our study should include. The detailed descriptions of crop rotation and intercropping of maize with soybean are as follows:

Crop rotation: Maize and soybean are cultivated successively in the same field. Maize is grown first (Dec-July + short fallow), followed by soybean the next year (January-July), and so on. Introducing a legume such as soybean in the rotation increases soil fertility through soybean nitrogen-fixation capacity. Rotating crops instead of growing maize continuously can also reduce pathogen pressure on the area. Eventually, it is a way of diversifying the farmer's sources of income.

Intercropping: Maize and soybean are cultivated simultaneously in the same field. Typically, one row of maize alternates with a row of soybean. Compared with monocropping, intercropping is expected to reduce pathogen pressure on the field and increase the total production by hectare, even if the yield by crop decreases because of crop competition. In intercropping of maize with soybean, this competition primarily occurs for sunlight as maize plant is tall, and soybean plant is short. As mentioned before, introducing soybean increases soil fertility.

The interviews also show that in response to increasing variability of rainfalls in the region, the project and extension agents have been testing early and late maturing varieties of soybean. Although both early and late maturing varieties are sowed around the end of December, early-maturing varieties can complete their cycle before the dry season. Late-maturing varieties need more time and are more exposed to droughts. However, if late-maturing varieties can complete their growing period, they are expected to give a better yield than early-maturing varieties. Nevertheless, the precise costs and benefits of early and late maturing varieties are still not very clear to the extension officers and farmers.

We use the findings from FGDs and key expert interviews and decide to conduct the CBA analysis for four CSA practices: (i) crop rotation with early-maturing soybean varieties (CR_EMS), (ii) crop rotation with late-maturing soybean varieties (CR_LMS), (iii) intercropping with early-maturing soybean varieties (IC_EMS), and (iv) intercropping with late-maturing soybean varieties (IC_LMS). We compare these CSA practices to business as usual (BAU) practice. In essence, continuous maize cultivation from December to July, renewed each year on the same piece of land.

4. Method

4.1. CBA model

To calculate the private profitability of the CSA practices for this study, we use an ex-ante CBA model. The model quantifies the profitability associated with each practice by comparing the differences between their net benefits. That is, whether the net benefit from the practices are equivalent to the difference in the flow of benefits and costs over the lifecycle or the lifespan of the practices as shown in Eq. 1:

$$Net\ Benefits\ [NB] = Benefits\ [B] - Costs[C] \quad (1)$$

We compute the ex-ante CBA through the following steps: (i) identification of all CSA practices of interest to the CSA-SuPER project, (ii) determining the benefits and cost that are most important from Iringa farmers' points of view, (iii) identification and categorization of the costs (i.e., implementation, maintenance, and operation) and the impacts (i.e., input required, labor saved, and outputs) associated with the selected CSA practices and how to measure them, (iv) quantitative estimation of the impact and over the practice lifespan, (v) monetizing the results into dollar (US$) terms, (vi) obtaining a discount rate at which future benefits and cost associated with the practice are discounted at relative to the present benefits and costs to derive their Net Present Value (NPV), (vii) calculating the NPV of each practice being considered, (viii) carrying out the sensitivity (i.e., due change in discount rate) analysis, and (ix) making a recommendation based on the findings.

We use the Internal Rate of Return (IRR) and NPV[4] to determine the economic value of each practice that has been accumulated over its lifespan. IRR represents the discount rate that makes the present value of the benefits that accrue in the future equal to zero and is measured in terms of the expected return. However, as compared to the NPV, IRR does not specify the interest rate in its computation. The adoption of practice (s) under consideration is considered feasible if the discount rate is lower than the IRR. IRR is computed as shown in Eq. 2.

$$IRR = \sum_{t=1}^{n} \frac{B_t - C_t)}{(1+r)^t} = NPV = 0 \qquad (2)$$

where B_t represents the benefits accrued at time t, C_t represents investment and recurrent costs incurred for a specific practice at time t, t represents the time, and r is the rate of return used.

NPV is the incremental net benefit of using a practice when compared with BAU over their lifespan. The recommendation to use practice is done if and only if the NPV is greater than 0 (i.e., if the costs of the practice are lower than its benefits). The computation of the NPV is as shown in Eq. 3.

$$NPV_i^{CSA-BAU} = \sum_{t=1}^{T} 1/(1+r)^t \{\sum_{i=1}^{n} MP_{it} * \Delta Y_{it}^{CSA-BAU} - \sum_{i=1}^{n} * \Delta C_{it}^{CSA-BAU} \qquad (3)$$

where MP_{jt} represent the market price of commodity i in time t; $\Delta Y_{it}^{CSA-BAU}$ represents the annual change in yield for commodity i when the CSA is compared with BAU practices; $\Delta C_{it}^{CSA-BAU}$represents the annual change in the costs associated with the installation of the CSA practice as compared with BAU practice; r represents the discount rate, and T shows the life cycle (or the lifespan) of the practice. Then the IRR is defined as the discount rate that makes the present value of the flow of the future net benefits precisely equal to zero.

To be able to model the physical response associated with the implementation of CSA, we assume that the physical response of the yield associated with the application of CSA practice follows a long plateau. A lag between the implementation of the practice and the receiving the yield follows this plateau (cf. Beattie, B., 1993). In the computation of NPV, installation (the costs incurred during the installation of practice, usually incurred at the start), maintenance

[4] Please see Juhász (2011) for detailed explnataion of IRR and NPV.

(the costs that farmers use to ensure a good performance of a given practice throughout the lifecycle, usually incurred per annum) and harvest costs are all considered.

In CBA calculation, it is essential to categorize a variable as either random or non-random for determining whether a variable should be evaluated at the mean or mode value. Therefore, it classifies all the variables (e.g., costs, outputs, lifecycle) used in computation into two main types: random and non-random. Random variables can be evaluated over the entire range of possible values and how they relate to cumulative distribution functions (CDF). Random variables such as yield per unit area and costs of inputs vary widely across the studied farmers. In contrast, non-random variables (e.g., market prices and discount rate) do not vary much. Specifically, the cost, output, and lifecycle variables and random and non-random classification variables used in the CBA model for this study are as follows. We use a 10% discount rate in our analysis.

4.2. Variables

The details of cost, output, and life cycle and land variables and their classification into random and non-random variables are as follows:

Costs: The costs include installation, maintenance, and harvest expenses computed yearly. Table 1 summarizes the subcategories for cost items (e.g., machines, equipment, input, services, and labor costs).

Some critical assumptions of the cost estimations are as follows. Farmers invest an hour and a half every day in learning about the practice during the first year that the practice is installed. The cost of technical support by the implementing agency is included in the estimation, equivalent to 23 US dollars per farmer.[5] The Maintenance costs are carried out periodically each year of the practice for the entire lifecycle, to maintain the performance of the practice. Labor costs constitute the number of hours needed, multiplied by the going wage rates per hour.

Outputs: Output indicators are market *prices* for maize and soybean, and *changes in yields* associated with the adoption of CSA practices - that is when the farmer starts to see an increase in the yields up to when the yields reach a maximum.

[5] The training costs are estimated directly by the KnK project staff and shared with us.

Life cycle and land variables: To estimate the lifecycle of practices, we ask farmers how long they intended to use the practices. Some farmers intend to use the practices forever. For those farmers, we estimate the lifetime of the practice based on the age of the farmer and life expectancy in Tanzania. The discount rate was derived from the interest rate that the farmers repay their loans per annum (i.e., an average of 10%). The land size refers to the portion of land allocated to the adopted practice and is estimated in hectares.

Table 1: Cost items by categories and subcategories

Cost category	Subcategories of costs	Items
Installation or implementation	Machines and equipment	Spraying machine, panga, rope, and hoe
	Inputs	Organic fertilizer, Di-ammonium phosphate (DAP), Calcium Ammonium nitrate (CAN), Urea, pesticides, maize seeds, soybean seeds, rhizobium.
	Services	Transportation
	Labor	Land opening, land preparation, fertilizer application, pesticide spraying, sowing, and weeding
	Technical support learning costs	Household time spent on learning the practice in the first two years. The cost of technical support to the farmers.
Maintenance	Machines and equipment's	Panga, rope, and hoe
	Inputs	Organic fertilizer, DAP, CAN, Urea, pesticides, maize seeds, soybean seeds, rhizobium.
	Services	Land preparation and transportation
	Labor	Land opening, land preparation, fertilizer application, pesticide spraying, sowing, and weeding
Harvest	Inputs	Plastic bags
	Labor	Harvest, threshing, cleaning, sorting, packaging.
	Services	Transportation

Classification into random and non-random variables: Random variables include all the costs (i.e., implementation, maintenance, and operation costs). Costs vary widely among households, reflecting the diversity of the production systems. The costs, therefore, capture the variability associated with an adopted technology.

Soybean production is uncertain as the practices are new and exposed to weather shocks. The crop yields are also considered as random variables as they capture the variability that reflects the distribution of the real variable in a population. The lifetime of the practice is highly related to the age of the respondent and the practice itself. Since age varies a lot across the studied farmers, the lifecycle is also categorized as a random variable. The prices of soybean, maize, and other inputs do not vary much across the study site. We, therefore, categorize them as non-random.

We first estimate the costs, outputs, and lifecycle variables of CSA practices separately for the farmers that adopt those CSA practices. Second, we calculate the costs, outputs, and lifecycle variables of BAU (continuous maize cultivation) for the same farmers, and compare them with CSA practices. Then we estimate the IRR and NPV for each practice and compare them among practices.

4.3 Robustness checks

Next, we conduct two robustness checks. First, we estimate the risk of farmers experiencing a loss from adopting the CSA practices in our study population through probabilistic CBA.[6] For this purpose, we use Monte Carlo simulation to develop a range of possible outcomes and their probabilities (for 10,000 iterations) to estimate the cumulative distribution functions of the IRR of four CSA practices separately. These functions are calculated from the probability distribution of the random variables included in the analysis. We use the cumulative distributions first to analyze the likelihood that the farmer will experience a loss. Here we assume that a farmer experiences a loss when IRR of using a CSA practice is less than the market interest rate and discount rate in our analysis, 10%.

Second, we test the sensitivity of NPV of using CSA practices to the changes in yields, variable costs, and crop prices. For this purpose, we change the variables for discount rates of farmers, prices per kg of maize and soybean, soybean, and maize yields per hectare, labor and input costs per hectare by 20%.[7] Then we re-estimate NPV for each variable at "base plus 10%" and "base minus 10%" to derive the optimistic and pessimistic NPV values, respectively. Finally, the difference of the re-estimated optimistic and pessimistic NPV values for each practice are then compared with the BAU case and report the difference as the

[6] For this purpose, we use the software @Risk (Palisade Corporation, 2013)

[7] The 20% change – as used in this study – was derived by taking the base value of the variable subjecting them to a change of plus (+) and minus (-) 10% change

sensitivities of the NPV for the CSA practices to changes in discount rates, prices, and variables costs.

5. Data description

The study uses both primary and secondary data sources. The research team collected primary data through a household survey using a structured questionnaire on farmers' production systems, including questions on general information about farmers and their involvement in FFBS, characterization of the CSA and BAU practices, the evolution of the yields with the different methods, market prices of agricultural products, and installation, maintenance, operation, and financial costs. The data collection team comprised of four enumerators from Sokoine University, who were trained for a day on the survey questionnaire and data collection process. Then we conducted a one-day pre-test of the questionnaire. All the issues that enumerators highlighted as challenging to them (e.g., in terms of translation) or the interviewee (in terms of understanding) were revisited, discussed, rectified and incorporated in the final survey.

The household survey was conducted in May 2019 at 10 KnK project villages. In total, 106 farmers from 10 project villages[8] were interviewed, and 74% of those interviewed were women, distributed evenly among the practices. For each practice, we interviewed over 20 farmers. We used a nonprobability snowballing sampling technique (Christopoulos, 2009) to sample the farmers. The paraprofessionals from the communities helped in identifying and contacting farmers to use at least one of the four CSA-practices.[9] To collect data for standard practices (i.e., the BAU) versus the improved methods, we relied on household recall information before and after the practices are implemented. The information collected from experts was used to fill the gaps generated during the surveys. Although all the farmers interviewed had participated in the implementation, the period of involvement varied by practices.

[8] The villages are Malagosi, Mlanda, Ikuvilo, Kikombwe, Igunda, Tagamenda, Wangama, Magulilwa, Wenda, Lyamgungwe and Ihemi

[9] Paraprofessionals are part of the KnK's structure. Every village has a farmer group with two "leading farmers" that we call paraprofessionals.

Most of the farmers in our sample engage in small-scale farming, with an average cultivated area ranging from 0.4 to 2 hectares per household. The main food crops are maize and beans, followed by millet, groundnuts, and cowpeas. Sunflower is the principal cash crop, and livestock production is a secondary activity adopted only by a few farmers. All the farmers are members of farmers' groups targeted by the KnK project and participated at least once in FFBS training. KnK project has trained more than 80% of studied farmers to grow soybean on experimental plots in FFBS and to grow soybean on their farms for the first time this year. The farmers usually grow one soybean variety among two early-maturing varieties (i.e., Safari and Yuole 2) and two late-maturing soybean varieties (i.e., Spike and Yuole 4). The seeds are purchased from agro-dealers or other farmers. Some farmers inoculate seeds with Rhizobium to benefit from the nitrogen fixation capacity of soybean. The Rhizobium is purchased from the farmer groups that oversee distributing it among farmers. Average hourly wages range from 737 to 872 Tanzanian Shillings.[10] The average price of soybean received by the farmers was about 0.75 US dollars per kg, and the average price maize was about 0.13 US dollars per kg.

Table 2: Distribution of farmers in our sample by villages and by practice

Village	Crop rotation-Early maturing seeds (CR-EMS)	Crop rotation-Late maturing seeds CR-LMS	Intercropping-Early maturing seeds IC - EMS	Intercropping-Late maturing seeds IC- LMS
Igunda	8	2	3	
Ihemi		11		
Ikuvilo	5		1	
Kikombwe	3		4	
Lyamgungwe	8	1		
Magulilwa	4	3		1
Malagosi			1	1
Mlanda	1	1	4	1
Tagamenda		7	6	10
Wangama		2	6	12
Total number of farmers surveyed	29	27	25	25
Number of villages	6	7	7	5

[10] It was calculated based on the daily wage and hours worked by a man labor. At the time of the survey the 1US$ was equal to 2298 Tanzanian Shillings.

Table 2 summarizes the distribution of CSA practices among villages and practices in the study region. The columns indicate the practices and rows show the number of farmers adopting the CSA method. The table shows that the total number of villages and households surveyed for each practice is similar. However, the adoption of practices is not equally distributed among the villages. On average, 11 farmers were interviewed per village. All farmers from Ihemi implement CR-LMS while farmers adopt different practices in other villages. Tagamenda and Malenda include many farmers taking up IC-LMS while other villages include few or no farmers adopting it, showing the uneven distribution of practices among villages. From our conversations with farmers, we have learned that access to agro-dealers and paraprofessionals influences the choice of practices. For instance, some villagers did not have access to some of the soybean varieties. Paraprofessionals were also a significant factor in the adoption of practices in a village, as they serve as role-models for farmers. As an example, when paraprofessionals chose not to try intercropping soybean with maize, very few farmers use the intercropping.[11]

6. Results

6.1 Main findings

We first present the relative lifecycle and average yields by CSA practices in Table 3. Farmers report that the lifecycle of crop rotation (the period that farmers intend to use this practice) is 15 years. In comparison, the lifecycle of intercropping ranges from 10 to 13 years. Farmers expect yields to reach a maximum in three years for CR-EMS, and in four years for other practices. Adopting CSA practices reduces the maize yield per hectare, as half the cultivated area is now dedicated to soybean cultivation. For example, in the case of CR-EMS, maize yield decreases from 2430 kg per hectare in the BAU to 1660 kg per hectare when introducing

[11] During our conversation with farmers, we learnt that access to agro-dealers and paraprofessionals influence the distribution of the practices. For instance, some villages did not have access to some of the soybean varieties. Paraprofessionals were also a big factor in the adoption of practices in a village, as they served as role-model for farmers. As an example, when they chose to not try intercropping soybean, very few farmers in the village would risk trying the new practice.

soybean in the rotation. It is plausible to argue that this decrease is caused by the reduced economies of scale with the smaller area cultivated by maize.

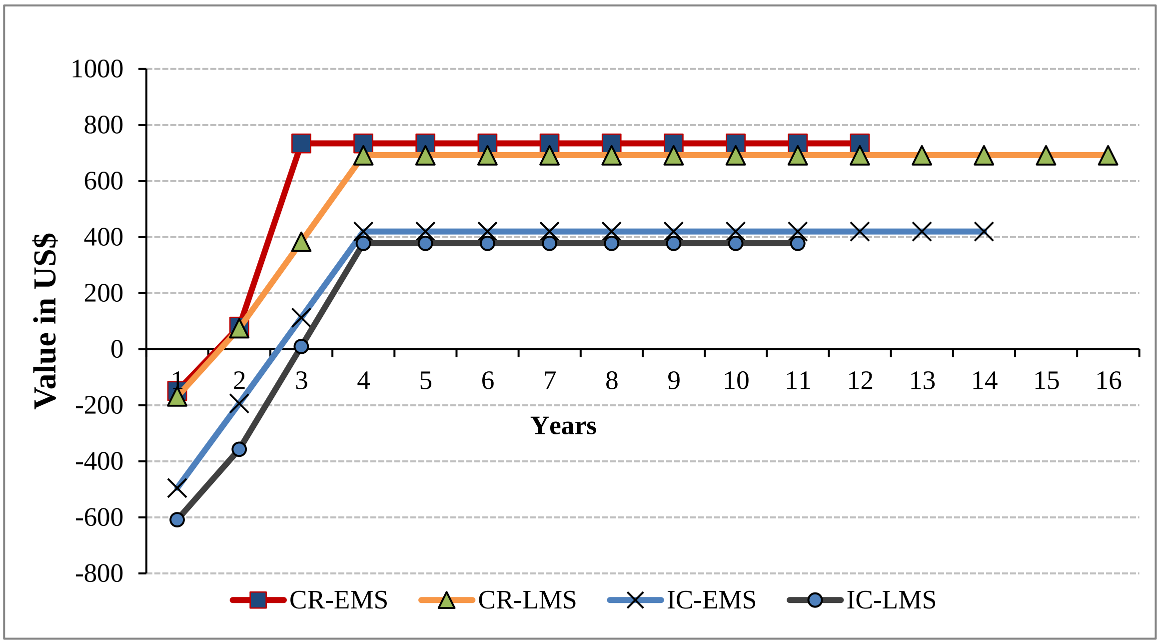
Table 3: Lifecycle, product affected by the practice and average yield per hectare (for BAU and CSA)

CSA Practice name	Life-cycle (years)	Products affected by the CSA practice over their lifetime	Response reaches the maximum (year)	Average yield per year [BAU]	Average yield per year [CSA]	Units
Crop rotation - Early maturing soybean (CR-EMS)	15	Maize	3	2430	1660	Kg
		Soybeans	3	0	140	Kg
Crop rotation - late-maturing soybean (CR-LMS)	15	Maize	4	2910	1810	Kg
		Soybeans	4	0	281	Kg
Intercropping - Early maturing soybean (IC-EMS)	13	Maize	4	2580	2270	Kg
		Soybeans	4	0	291	Kg
Intercropping - late-maturing soybean (IC-LMS)	10	Maize	4	2380	2650	Kg
		Soybeans	4	0	233	Kg

The soybean and maize yields vary among the farmers adopting different practices. For instance, on average, farmers adopting IC-EMs can annually produce 290 kg of soybean and 2270 kg of maize per hectare of practice. Farmers using IC-LMS can produce 230 kg per hectare of soybean and 2650 kg per hectare of maize with IC-LMS. Instead, farmers utilizing CR-EMS can produce about 140 kg per hectare soybean and 1660 per hectare, and farmers adopting CR-LMS can produce 281 kg per hectare soybean and 1810 per hectare. These results show that maize yields are lower for the farmers adopting crop rotation when compared to those adopting intercropping.

We also note that the average yields of early and late maturing soybean are about the same for all practices except CR-EMS. This might be caused by the imprecision in our yield estimates. Many farmers in our sample are new to soybean farming, and few used late-maturing yields. Moreover, the yields of early and late maturing varieties depend on the timing of the rain. When the rains subside early, early maturing types show better yields; when the rains continue for a more extended period, late-developing beans are more productive.

Figure 2: Incremental net benefits per farmer for the four CSA Practices over their lifecycle



We find that farmers adopting crop rotation practices reach higher profitability in a shorter period when compared to intercropping. Figure 2 presents the incremental net benefits of the four CSA practices for an average farmer over the life-cycle of the practices. During the lifetime of the practices, the installation costs take a significant amount of financial resources causing the incremental net benefits of all the four practices to be lower than zero in the early years. Farmers need to invest 200US$ per hectare to adapt crop-rotation practices, and about 700US$ per hectare to take-up intercropping practices.[12] Crop rotation practices become profitable in the third year, and intercropping practices become profitable in the fourth year after the introduction of the practices, implying that intercropping practice needs more time for impact. The peak incremental net benefits of the crop-rotation practices for an average farmer are about 800 US$ per hectare, while the net benefits of intercropping are about 400 US$ per hectare.

[12] In the program, some of this investment (e.g. training costs) is made by the KnK program.

These results show that investment in CSA practices is profitable for farmers. However, they need to finance the installation costs of the first two years of the activities.

The estimates of NPV, IRR, and a pay-back period, shown in Table 4, are in-line with our previous findings. Farmers adopting crop-rotation practices report higher profitability than farmers using intercropping. In all the four practices, the IRR associated with those practices is higher than the discount rate of farmers (10%), indicating that the adoption of the practices are profitable and can be pursued. The pay-back period of crop-rotation practices is short - about two years -, but intercropping's pay-back period is long and about seven-year. All methods had a slightly different payback period; however, they all constitute a pot of promising investment options, because they yield positive benefits for farmers. Notably, two years of investment in the crop rotation can repay the cost used for implementing the practice in full – and this may act as a motivation for its adoption by other farmers.

Table 4: The net present value, internal rate of return, the pay-back periods for CSA practices, US$ per hectare

CSA practices	Net present value (NPV) discounted at 10%	Internal rate of return (IRR)	Payback period
Crop rotation – Early maturing soybean (CR-EMS)	4,028	200	2
Crop rotation – late-maturing soybean (CR-LMS)	4,284	148	2
Intercropping – Early maturing soybean (IC-EMS)	1,667	37	5
Intercropping – late-maturing soybean (IC-LMS)	743	23	7

Costs of implementing intercropping are higher than the costs for crop rotation practices. Table 5 presents the installation, maintenance, and operation costs for the four CSA practices relative to the BAU case. Crop rotation practices require about 130 US$ per hectare, and intercropping practices require more, about 433 US$ dollars per hectare investments in installation costs. Similarly, maintenance and operation costs are higher for intercropping than crop rotation practices. This finding explains the higher profitability of crop rotation practices when compared to intercropping.

Table 5: The difference in the average cost of implementing, maintaining and operating the activities for CSA practices when compared to BAU, annual numbers in US$ per hectare

CSA practices	Change in installation costs, relative to BAU	Change in maintenance costs, relative to BAU	Change in operation costs relative to BAU
Crop rotation – Early maturing soybean (CR-EMS)	133.6	-96.3	15
Crop rotation – Late maturing soybean (CR-LMS)	132.8	-111.5	36
Intercropping – Early maturing soybean (IC-EMS)	435	184	173
Intercropping – Late maturing soybean IC-LMS (IC-LMS)	453	184	173

Our detailed conversations with farmers shed some light on the reasons behind the higher cost of implementing intercropping than crop rotation practices. Farmers state that they use inputs for soybean and maize separately in the field. There is no efficiency gain in terms of input use for them. Also, labor costs increase because farmers spend more time on intercropping in the field for sowing and weeding, pesticide spraying, and fertilizer application. Moreover, the harvest is also less efficient with intercropping than crop rotation.

6.2 Robustness checks

Next, we test the robustness of our results. First, we analyze the probability of farmers in our study population to experience a loss from investing in CSA practices. For this purpose, we predict cumulative distributions for the IRR of investment in four CSA practices, using Monte Carlo simulations. When the predicted IRR is less than the cost of capital, which we assume as 10%, then a farmer might make a loss. Figure 3 shows the results for each CSA practice. In the Figure, x-axes indicate IRR, and y-axes show the predicted cumulative probabilities of the corresponding IRR. There is a 90% chance that the IRR from investing in CR-EMS is between 124% and 172%, and the IRR from adopting CR-LMS is between 186% to 215%. Almost no farmers in the study population might lose money after investing in crop rotation, as the entire cumulative distributions are almost all above 100%.

How do changes in costs, yields, and prices affect the NPV of adopting CSA practices? To answer this, we change discount rates, costs of inputs and labor, soybean and maize yields per hectare, and maize and soybean prices per kg by 20%. Then we re-estimate the change in NPVs for the practices and compare those NPVs with BAU, respectively. Figure 4 shows the results. In the Figure, each bar indicates the changes in US$ per hectare for 20% in the corresponding item. We find that NPV is most sensitive to the changes in the discount rate. 20% change in the discount rate decreased NPVs to decrease by 1961 to 6938 US$, depending on the practice. NPV is moderately sensitive to the changes in soybean yield and prices all the practices, while it is least sensitive to changes in maize prices (Fig. S5, S6, S7, and 4). However, the NPV adopting intercropping is more sensitive to changes in maize yield and changes in labor costs when compared to crop rotation practices. For instance, a 20% change in maize prices increases the NPV for IC-EMS by US$ 229 and the NPV for the adoption of IC-EMS by US$ 282 per hectare.

In contrast, the same rise in prices, increase the NPV of CR-LMS by 42 US$ and that of CR-LMS by 103 US$ per hectare. Maize yields and labor costs are higher for intercropping than crop rotations practices (Section 6.1), explaining the sensitivity of NPV for intercropping to the changes in labor costs and maize yields. These results imply that the profitability of these practices would be lower under higher discount rates (e.g., interest rates), lower soybean yields, and prices. Furthermore, if the labor cost prices were low, and maize prices were high, the profitability of intercropping could be higher than crop rotation practices.

Figure 3: Cumulative distribution of the internal rate of return (IRR) by CSA practices

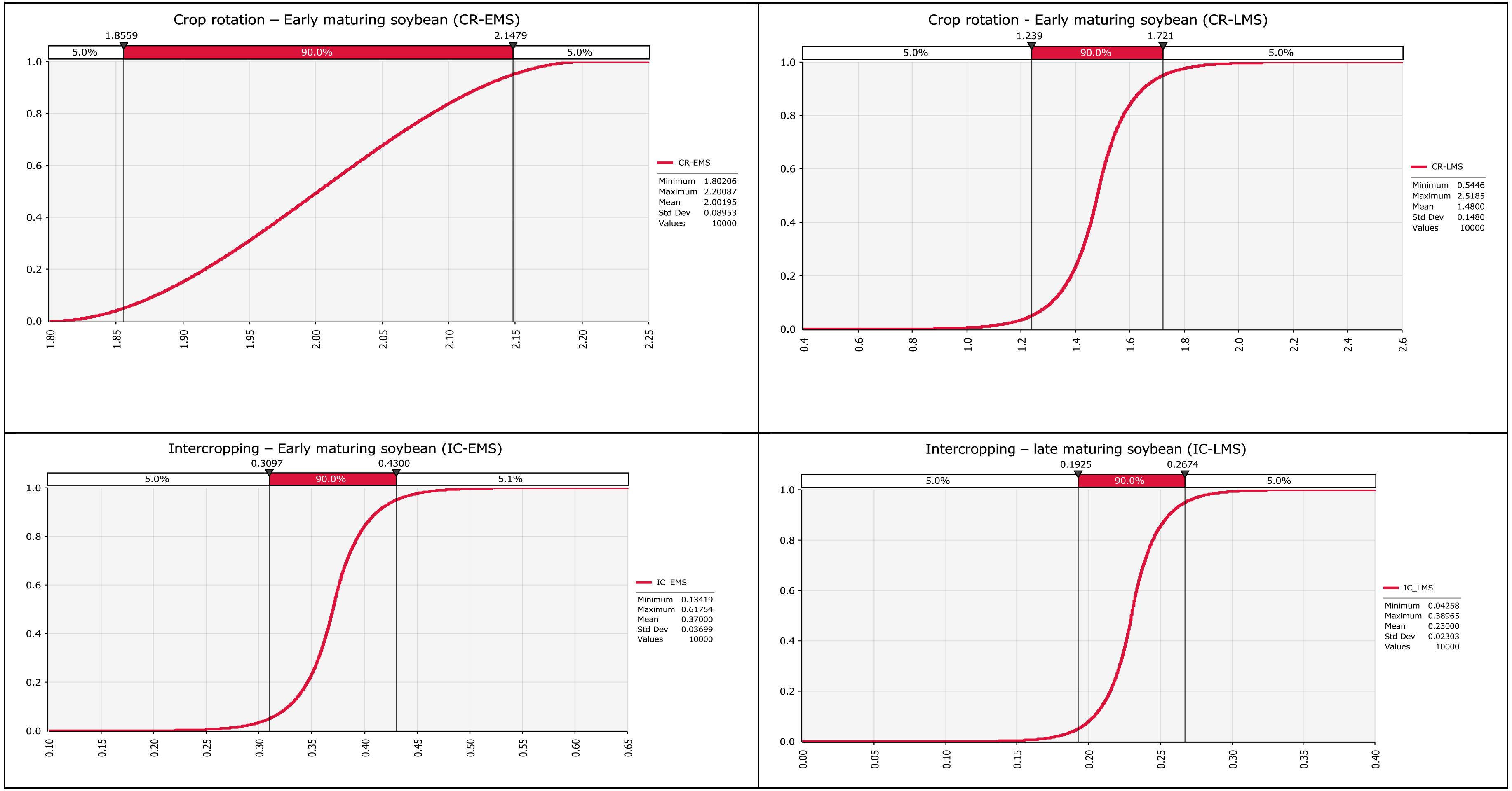
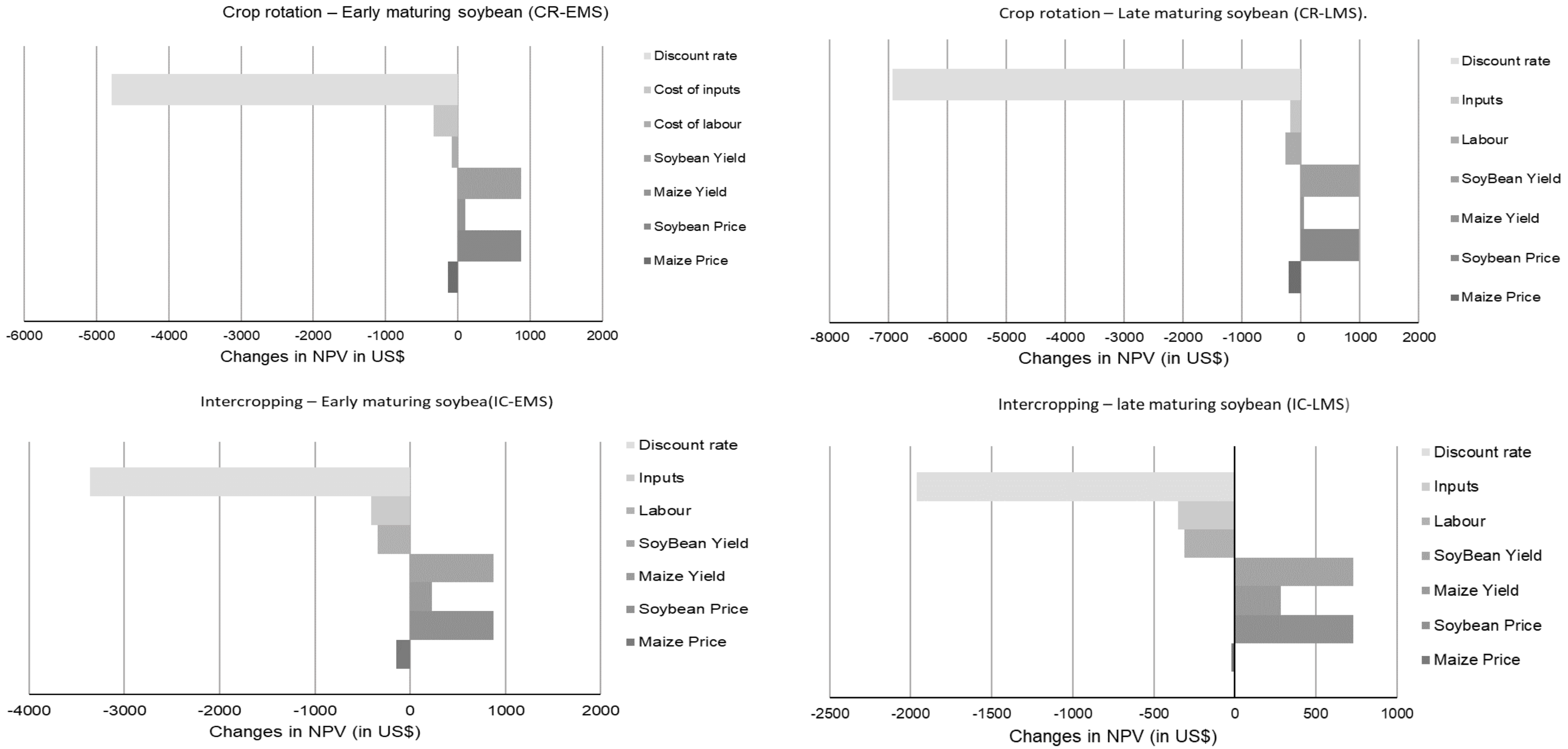


Figure 4: The sensitivity of NPV to changes in the discount rate, cost of variable inputs, cost of labor, yield per unit area, and the price per unit of output, US$ per hectare



7. Conclusions

Climate change will lead to agricultural losses for small-scale farmers in developing countries. Tanzania is among those developing countries, where climate change will increase the variability in rainfall and the temperatures, thereby dropping agricultural production. Tanzanian government aims to mitigate those negative impacts and enhance farmers' adaptive capacities through various policy initiatives, including the diffusion of CSA practices.

In this study, we used CBA to estimate the profitability of CSA practices for small-scale farmers in rural Iringa, Tanzania. Through an FGD, four CSA practices adopted in the region were identified. They included crop rotation or intercropping maize with early or late-maturing soybean varieties. Results showed that those CSA practices are all financially profitable. Investments in crop-rotation practices have higher net present values, internal rate of returns and payback periods than intercropping practices. Crop rotation of maize with early and late-maturing soybean varieties have the shortest payback periods of two years each, while intercropping of maize with those soybean varieties have a more extended payback period of five to seven years. We did not find any differences in the profitability of early and late maturing seeds. Our sensitivity analysis showed that the risk of experiencing a loss from investing in all four practices is low. However, the profitability of these practices depends on the farmers' discount rates (e.g., market interest rates), labor costs, soybean yields, and maize prices. Mainly the economic returns to the practices decreased by the increases in discount rates, and intercropping becomes more profitable when labor costs are low, and maize prices are high.

These findings imply that investments in CSA practices, such as crop rotation and intercropping of maize with soybean, are profitable for small-scale farmers in Tanzania. Specifically, the payback period for the investment in these practices, especially for crop-rotation practices, is short, about two to seven years. Moreover, the crop rotation with soybean decreases the maintenance costs for the farmers, as farmers need to purchase less fertilizer to supplement the soil with soybean. This makes crop rotation with soybean a very suitable investment option for the small-scale farmers in rural areas with limited financial power. To finance the investment in the crop rotation, farmers' access to finance and savings can be improved. Nevertheless, policymakers should consider the market context (e.g., interest rates, labor costs, soybean yields and prices, and maize prices) before the promotion of the practices. For instance, if the market interest rates are high or soybean prices are low, then adopting these practices might not be profitable. Also, when labor costs are low, and maize prices are high, promoting intercropping instead of crop rotation might be a more logical policy choice.

We note a few methodological issues concerning our results. First, our results are relevant in the context of Tanzania. Further research should be done to understand the influence of market conditions in other countries on the profitability of these practices. Second, our analysis is deterministic, not considering yield variance and price variance into account. We might therefore, underestimate the variance decreasing benefits of practices considered in our study. Third, in our sample, the average cultivated area is smaller for intercropping than crop rotation, as intercropping has been recently introduced to the farmers. Small cultivation area might drive up the costs and reduce overall profitability figures for intercropping in our study. Further research might replicate our study in about five years to test the robustness of our results.

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Appendix: Survey questions

Cost-Benefit Analysis, Household Survey

Intercropping: Maize/Late-maturing soybean

General comments

Thank you for the opportunity to speak with you. We represent CARE Tanzania, in cooperation with the International Center for Tropical Agriculture, Wageningen University & Research and Sokoine University of Agriculture. This questionnaire intends to collect data aimed at helping us to identify farming practices that sustainably increase agricultural productivity and incomes while helping farmers to adapt to changing climate conditions. In addition, the data will help us to understand how Farmer Field & Business Schools (FFBS) and Village Community Bank (VICOBAs) can help farmers to adopt these practices.

We are now collecting information to understand the costs and the benefits associated with the intercropping of maize and late-maturing soybean in comparison with maize monocropping. This survey will help us understand how profitable it is for farmers, and the role of FFBS and VICOBAs in adopting this practice. The respondents for this survey shall be decision makers regarding production and other agricultural activities in the household, and must be at least 18 years old. Participation in this survey is voluntary. Information obtained is strictly for academic and research purposes and responses obtained will be confidential. This interview is voluntary and will take approximately one and a half hour. Your participation will be highly appreciated.

By signing this form, I agree that;

1. I am voluntarily taking part in this survey. I can stop the interview at any time or refuse to answer a question;
2. I don't expect to receive any benefit or payment for my participation;
3. I have been able to ask any questions that I have, and I understand that I am free to contact the researcher with any questions I may have in the future.

Participants name …………………………….. Participants Signature ……………………………...

Date [____/______/_____] (*Date/Month/Year)*

Identification Variables

Key informant Name: ________________________ Household head: _____ (*1=yes, 2=no*)

Age: ______________ Sex: ______ (*1=Male, 2=Female*)

Total land size: ___________ (acre)

Enumerator's name: _________________ Questionnaire ID: _______________

Interview start time: __________ Interview end time: _________

Village: ______________________ Ward: __________________

Farmer's phone number: ___________________

Section 1: Farmers Field and Business schools (FFBS)

1. Please fill in table 1 with information about the farmer's participation in FFBS

Table 1 : Farmer's participation in FFBS	
1.1. Is there any farmer field and business school in your village? (*1=yes, 2=no*)	
1.2. Have you or your spouse participated in FFBS activities? (*1=yes, 2=no*)	
1.3. How many times since the beginning of the project? (*1= once or twice, 2= 3 to 4 times, 3= 5 to 10 times, 4= More than 10 times*)	
1.4. Did the participant learn how to practice the maize – soybean intercropping at the FFBS? (*1=yes, 2=no*)	

Section 2: Characterizing Intercropping versus Maize monocropping (business as usual).

2. In table 2, please describe precisely the two practices.

Table 2 : Characterizing Intercropping and Maize monocropping

	a. Intercropping		b. Maize monocropping
2.1.i. Maize spacing *Row spacing*plant spacing (cm)*			
2.1.ii. Maize sowing month			
2.1.iii. Maize harvesting month			
2.1.iv. Soybean spacing *Row spacing*plant spacing (cm)*			
2.1.v. Soybean sowing month			
2.1.vi. Soybean harvesting month			
2.2. Please specify which maize varieties you cultivate			
2.3. Please specify which soybean varieties you cultivate *Soybean: 1=safari, 2=yuole 2, 3=spike, 4=yuole 4, 5=other (specify)*	i. Last year	ii. This year	
2.4. What is the total land size you use for each practice? *(acre)*			
2.5. When did you start using these practices? *1=this season, 2=2 seasons ago, 3=3 seasons ago, 4=4 seasons ago, and so on.*			
2.6. How long do you intend to use this practice? *1=1 more season, 2=2 more seasons, 3=3 more seasons, 4=4 more seasons and so on.*			

Section 3: Changes in productivity

Subsection 3.1: Shape of the physical response

3.3. If possible, please describe the evolution of the yield when using Intercropping

Table 3.1: Expected evolution of the yield with Intercropping				
Crop	a. How many years pass before you begin to see a change in yield (compared with the BAU)?	b. How many years pass before the yield reaches its maximum with this practice?	c. What is the maximum harvest you expect to reach with this practice? *(number of units)*	d. Unit of harvest *1=kg, 2=bag of 130kg, 3=bag of 100kg, 4=bags of seven plastics, 5=plastic, 6=other (specify)*
1. Maize				
2. Soybean				

Subsection 3.2: Expected harvest with Intercropping

3.2. Please fill in the table 3.2 with the yields you got last year and these that can be expected given the areas provided in question 2.4,when **using** Intercropping, for each crop.

Table 3.2 : Harvest with Intercropping					
After introducing Intercropping….					
Crop	a. what harvest did you get at the end of last year?	b. what is the expected minimum harvest at the end of this year?	c. what is the expected average harvest at the end of this year?	d. what is the expected maximum harvest at the end of this year?	e. Unit of harvest *1=kg, 2=bag of 130kg, 3=bag of 100kg, 4=plastic, 5=liter, 6=other (specify)*
1. Maize					

Subsection 3.3: Expected harvest **without** Intercropping

3.3. Please fill in the table 3.3 with the yields that can be expected given the areas provided in question 2.4, when **not using** Intercropping, for each crop.

Table 3.3: Yield **without** Intercropping				
If Intercropping is **not** used, what is the estimated…				
Crop	a. expected minimum harvest?	b. expected average harvest?	c. expected maximum harvest?	d. Unit of harvest *1=kg, 2=bag of 130kg, 3=bag of 100kg, 4=bags of seven plastics, 5=plastic, 6=other (specify)*
1. Maize				
2. Soybean				

Section 4: Prices at farm level

4.1. Please fill the table 4 with the different measurement units and corresponding prices for each crop.

Table 4 : Pricing and price variability				
Crop	a. Units *1=kg, 2=bag of 130kg, 3=bag of 100kg, 4=bags of seven plastics, 5=plastic, 6=other (specify)*	b. Minimum Price *(TZS/ unit)*	c. Average Price *(TZS/ unit)*	d. Maximum Price *(TZS/ unit)*
Maize				
Soybean				

4.2.a. How long is an average day of work? *(hours)* ______________________

4.2.b. What is the cost of hiring labor for a day? (*TZS)* _______________________

Section 5: Installation costs

Subsection 5.1: Installation costs

5.1. Please fill in Table 3 with information about the costs associated with the implementation of Crop Rotation or Maize monocropping (costs happening in the first year of the practice)

Table 5.1 : Installation Costs

Category	a. List of items	b. Price per Unit *(TZS/unit)*	Quantity *(# of units)*	
			c. With Intercropping	d. Without Intercropping
1. Machines/ Equipment *1=power tiller, 2= spraying machine, 3=panga, 4=rope, 5=poles, 6=hoe, 7=other (specify).*				
2. Inputs *1=organic fertilizers, 2=inorganic fertilizers, 3=pesticides, 4=fungicides, 5=herbicides, 6=maize seeds, 7=soybean seeds, 8=Rhizobium, 9=other (specify)* *(detail the name of fertilizers and aggregate other prices)*				
3. Services *1=renting land, 2=renting tiller, 3= renting tractor,4=renting cows, 5=transport, 6=other (specify)*				
4. Labor *1=land opening, 2=land preparation, 3= fertilizer application, 4=pesticides spraying, 5=sowing, 6=transplanting, 7=weeding, 8=other (specify)*				

Subsection 5.2: Financial aspect of the installation costs

5.2. Did you receive any loan to finance the installation costs mentioned before? If yes, please fill in table 5.2 with the loans used to finance agricultural expenses.

Table 5.2 : Financial costs associated with installation costs

a. Where did you receive a loan? *(list below)*	b. What did you use the loan for? *(list below)*	c. What is the amount of the loan you took? (*TZS*)	d. When did you receive the loan? *(mm/yy)*	e. When is (was) the last repayment of the loan? *(mm/yy)*	f. What is the total payment you make for the loan? (*TZS*)	What is the interest rate of the loan?	
						g. Interest rate *(%)*	h. Unit

a. **List of institutions**: *1=bank, 2=VSLA/VICOBA, 3=microfinance institutions, 4=Agro dealers, 5=NGO (e.g. OneAcre foundation), 6=friends/relatives, 7=money lenders, 8=mobile money, 9=other (specify)*

b. ***List of items:*** *1. Machines/ Equipment: 1.1=tractor, 1.2=power tiller, 1.3=spraying machine, 1.4=panga, 1.5=rope, 1.6=poles, 1.7=hoe, 1.8=other (specify). 2. Inputs: 2.1=organic fertilizers, 2.2=inorganic fertilizers, 2.3=pesticides, 2.4=fungicides, 2.5=herbicides, 2.6=maize seeds, 2.7=soybean seeds, 2.8=other (specify). 3. Services: 3.1=renting land, 3.2=renting tiller, 3.3= renting tractor, 3.4=transport, 3.5= other (specify). 4. Labor: (4.1=land opening, 4.2=land preparation, 4.3= fertilizer application, 4.4=pesticides spraying, 4.5=sowing, 4.6=transplanting, 4.7=weeding, 4.8=other (specify)*

IMPORTANT: for column b, mark items with * if they were purchased for the CSA practice, **if the loan was used for both practices. Ex: for soybean seeds, write 2.7*

h. **List of units**: *1=monthly, 2=3 monthly, 4=6 monthly, 4=annually, 5=other (specify)*

Section 6: Maintenance costs

Subsection 6.1: Maintenance costs

6.1. Please fill in Table 6.1 with information about the maintenance costs needed when Intercropping is and is not used. Maintenance costs are carried out periodically and are necessary to keep a farming practice working properly over the entire lifetime.

Table 6.1: Maintenance costs

Category	a. Items *(list)*	b. Price per Unit *(TZS/unit)*	Quantity *(# of units)*	
			c. With Intercropping	d. Without Intercropping
1. Machines/ Equipment *1=power tiller, 2= spraying machine, 3=panga, 4=rope, 5=poles, 6=hoe, 7=other (specify).*				
2. Inputs *1=organic fertilizers, 2=inorganic fertilizers, 3=pesticides, 4=fungicides, 5=herbicides, 6=maize seeds, 7=soybean seeds, 8=Rhizobium, 9=other (specify)* *(detail the name of fertilizers and aggregate other prices)*				
3. Services *1=renting land, 2=renting tiller, 3= renting tractor,4=renting cows, 5=transport, 6=other (specify))*				
4. Labor *1=land opening, 2=land preparation, 3= fertilizer application, 4=pesticides spraying, 5=sowing, 6=transplanting, 7=weeding, 8=other (specify)*				

Subsection 6.2: Financial aspect of the maintenance costs

6.2. Did you receive any loan in addition to (if any) the loans you indicated before to finance the maintenance costs? If yes, please fill in table 6.2 with the loans used to finance agricultural expenses?

Table 6.2 : Financial costs associated with maintenance costs

a. Where did you receive a loan? *(List below)*	b. What did you use the loan for? *(List below)*	c. What is the amount of the loan you took? (*TZS)*	d. When did you receive the loan? *(mm/yy)*	e. When is (was) the last repayment of the loan? *(mm/yy)*	f. What is the total payment you make for the loan? (*TZS*)	What is the interest rate of the loan?	
						g. Interest rate *(%)*	h. Unit

a. **List of institutions**: *1=bank, 2=VSLA/VICOBA, 3=microfinance institutions, 4=Agro dealers, 5=NGO (e.g. OneAcre foundation), 6=friends/relatives, 7=money lenders, 8=mobile money, 9=other (specify)*

*b**. List of items:** 1. Machines/ Equipment: 1.1=tractor, 1.2=power tiller, 1.3=spraying machine, 1.4=panga, 1.5=rope, 1.6=poles, 1.7= hoe, 1.8=other (specify). 2. Inputs: 2.1=organic fertilizers, 2.2=inorganic fertilizers, 2.3=pesticides, 2.4=fungicides, 2.5=herbicides, 2.6=maize seeds, 2.7=soybean seeds, 2.8=other (specify). 3. Services: 3.1=renting land, 3.2=renting tiller, 3.3= renting tractor, 3.4=transport, 3.5= other (specify). 4. Labor: (4.1=land opening, 4.2=land preparation, 4.3= fertilizer application, 4.4=pesticides spraying, 4.5=sowing, 4.6=transplanting, 4.7=weeding, 4.8=other (specify)*

IMPORTANT: for column b, mark items with * if they were purchased for the CSA practice, **if the loan was used for both practices. Ex: for soybean seeds, write 2.7*

h. **List of units**: *1=monthly, 2=3 monthly, 4=6 monthly, 4=annually, 5=other (specify)*

Section 7: Harvest costs

Subsection 7.1: Harvest costs for Maize

7.1. Please estimate the cost of inputs, services, and labor included in the harvest costs for Maize. Fill in table 7.1 with information.

Table 7.1: Harvest costs, Maize

Category	a. Item *(list)*	b. Price per Unit *(TZS/unit)*	Quantity *(# of units)*	
			c. With Intercropping	d. Without Intercropping
1. Inputs *1=bags of 130kg, 2=bags of 100kg, 3=plastic, 4=other (specify)*				
2. Labor *1=harvesting, 2=threshing, 3=cleaning, 4=sorting,5=packaging, 6=other (specify)*				
3. Services *1=transport, 2=market fees, 3=taxes, 4=other (specify)*				

Subsection 7.2: Harvest costs for Soybean

7.2. Please estimate the cost of inputs, services, and labor included in the harvest costs of Soybean. Fill in table 7.2 with the information.

Table 7.2: Harvest Costs, Soybean

Category	a. Item *(list)*	b. Price per Unit *(TZS/unit)*	Quantity *(# of units)*	
			c. With Intercropping	d. Without Intercropping
1. Inputs *1=bags of 130kg, 2=bags of 100kg, 3=plastic, 4=other (specify)*				
2. Labor *1=harvesting, 2=threshing, 3=cleaning,*				

4=sorting,5=packaging, 6=other (specify)				
3. Services *1=transport, 2=market fees, 3=taxes, 4=other (specify)*				

Subsection 7.3: Financial aspect of the maintenance costs

7.3. Did you receive any loan in addition to (if any) the loans you indicated before to finance the harvest costs? If yes, please fill in table 7.3 with the loans used to finance agricultural expenses.

Table 7.3 : Financial costs associated to harvest costs

a. Where did you receive a loan? *(List below)*	b. What did you use the loan for? *(List below)*	c. What is the amount of the loan you took? (*TZS*)	d. When did you receive the loan? *(mm/yy)*	e. When is (was) the last repayment of the loan? *(mm/yy)*	f. What is the total payment you make for the loan? (*TZS*)	What is the interest rate of the loan?	
						g. Interest rate *(%)*	h. Unit:

a. **List of institutions**: *1=bank, 2=VSLA/VICOBA, 3=microfinance institutions, 4=Agro dealers, 5=NGO (e.g. OneAcre foundation), 6=friends/relatives, 7=money lenders. 8=mobile money, 9=other (specify)*

*b**. List of items:** 1. Machines/ Equipment: 1.1=tractor, 1.2=power tiller, 1.3=spraying machine, 1.4=panga, 1.5=rope, 1.6=poles, 1.7= hoe, 1.8=other (specify). 2. Inputs: 2.1=organic fertilizers, 2.2=inorganic fertilizers, 2.3=pesticides, 2.4=fungicides, 2.5=herbicides, 2.6=maize seeds, 2.7=soybean seeds, 2.8=other (specify). 3. Services: 3.1=renting land, 3.2=renting tiller, 3.3= renting tractor, 3.4=transport, 3.5= other (specify). 4. Labor: (4.1=land opening, 4.2=land preparation, 4.3= fertilizer application, 4.4=pesticides spraying, 4.5=sowing, 4.6=transplanting, 4.7=weeding, 4.8=other (specify)*

IMPORTANT: for column b, mark items with * if they were purchased for the CSA practice, **if the loan was used for both practices. Ex: for soybean seeds, write 2.7*

h. **List of units**: *1=monthly, 2=3 monthly, 4=6 monthly, 4=annually, 5=other (specify)*

Cost-Benefit Analysis, Household Survey

Intercropping: Maize/Early-maturing soybean

General comments

Thank you for the opportunity to speak with you. We represent CARE Tanzania, in cooperation with the International Center for Tropical Agriculture, Wageningen University & Research and Sokoine University of Agriculture. This questionnaire intends to collect data aimed at helping us to identify farming practices that sustainably increase agricultural productivity and incomes while helping farmers to adapt to changing climate conditions. In addition, the data will help us to understand how Farmer Field & Business Schools (FFBS) and Village Community Bank (VICOBAs) can help farmers to adopt these practices.

We are now collecting information to understand the costs and the benefits associated with the intercropping of maize and early-maturing soybean in comparison with maize monocropping. This survey will help us understand how profitable it is for farmers, and the role of FFBS and VICOBAs in adopting this practice. The respondents for this survey shall be decision makers regarding production and other agricultural activities in the household, and must be at least 18 years old. Participation in this survey is voluntary. Information obtained is strictly for academic and research purposes and responses obtained will be confidential. This interview is voluntary and will take approximately one and a half hour. Your participation will be highly appreciated.

By signing this form, I agree that;

4. I am voluntarily taking part in this survey. I can stop the interview at any time or refuse to answer a question;
5. I don’t expect to receive any benefit or payment for my participation;
6. I have been able to ask any questions that I have, and I understand that I am free to contact the researcher with any questions I may have in the future.

Participants name …………………………….. Participants Signature ……………………………...

Date [____/______/_____] (*Date/Month/Year)*

Identification Variables

Key informant Name: ________________________ Household head: _____ (*1=yes, 2=no*)

Age: ______________ Sex: ______ (*1=Male, 2=Female*)

Total land size: __________ (acre)

Enumerator's name: _________________ Questionnaire ID: _______________

Interview start time: _________ Interview end time: ________

Village: ______________________ Ward: __________________

Farmer's phone number: ___________________

Section 1: Farmers Field and Business schools (FFBS)

1. Please fill in table 1 with information about the farmer's participation in FFBS

Table 1 : Farmer's participation in FFBS	
1.1. Is there any farmer field and business school in your village? (*1=yes, 2=no*)	
1.2. Have you or your spouse participated in FFBS activities? (*1=yes, 2=no*)	
1.3. How many times since the beginning of the project? (*1= once or twice, 2= 3 to 4 times, 3= 5 to 10 times, 4= More than 10 times*)	
1.4. Did the participant learn how to practice the maize – soybean intercropping at the FFBS? (*1=yes, 2=no*)	

Section 2: Characterizing Intercropping versus Maize monocropping (business as usual).

2. In table 2, please describe precisely the two practices.

Table 2 : Characterizing Intercropping and Maize monocropping		
	a. Intercropping	b. Maize monocropping
2.1.i. Maize spacing *Row spacing*plant spacing (cm)*		
2.1.ii. Maize sowing month		
2.1.iii. Maize harvesting month		
2.1.iv. Soybean spacing *Row spacing*plant spacing (cm)*		
2.1.v. Soybean sowing month		

2.1.vi. Soybean harvesting month			
2.2. Please specify which maize varieties you cultivate			
2.3. Please specify which soybean varieties you cultivate *Soybean: 1=safari, 2=yuole 2, 3=spike, 4=yuole 4, 5=other (specify)*	i. Last year	ii. This year	
2.4. What is the total land size you use for each practice? *(acre)*			
2.5. When did you start using these practices? *1=this season, 2=2 seasons ago, 3=3 seasons ago, 4=4 seasons ago, and so on.*			
2.6. How long do you intend to use this practice? *1=1 more season, 2=2 more seasons, 3=3 more seasons, 4=4 more seasons and so on.*			

Section 3: Changes in productivity

Subsection 3.1: Shape of the physical response

3.3. If possible, please describe the evolution of the yield when using Intercropping

Table 3.1: Expected evolution of the yield with Intercropping

Crop	a. How many years pass before you begin to see a change in yield (compared with the BAU)?	b. How many years pass before the yield reaches its maximum with this practice?	c. What is the maximum harvest you expect to reach with this practice? *(number of units)*	d. Unit of harvest *1=kg, 2=bag of 130kg, 3=bag of 100kg, 4=bags of seven plastics, 5=plastic, 6=other (specify)*
1. Maize				
2. Soybean				

Subsection 3.2: Expected harvest with Intercropping

3.2. Please fill in the table 3.2 with the yields you got last year and these that can be expected given the areas provided in question 2.4,when **using** Intercropping, for each crop.

Table 3.2 : Harvest with Intercropping					
After introducing Intercropping….					
Crop	a. what harvest did you get at the end of last year?	b. what is the expected minimum harvest at the end of this year?	c. what is the expected average harvest at the end of this year?	d. what is the expected maximum harvest at the end of this year?	e. Unit of harvest *1=kg, 2=bag of 130kg, 3=bag of 100kg, 4=plastic, 5=liter, 6=other (specify)*
1. Maize					
2. Soybean					

Subsection 3.3: Expected harvest **without** Intercropping

3.3. Please fill in the table 3.3 with the yields that can be expected given the areas provided in question 2.4, when **not using** Intercropping, for each crop.

Table 3.3: Yield without Intercropping				
If Intercropping is **not** used, what is the estimated…				
Crop	a. expected minimum harvest?	b. expected average harvest?	c. expected maximum harvest?	d. Unit of harvest *1=kg, 2=bag of 130kg, 3=bag of 100kg, 4=bags of seven plastics, 5=plastic, 6=other (specify)*
1. Maize				

Section 4: Prices at farm level

4.1. Please fill the table 4 with the different measurement units and corresponding prices for each crop.

Table 4 : Pricing and price variability				
Crop	a. Units *1=kg, 2=bag of 130kg, 3=bag of 100kg, 4=bags of seven plastics, 5=plastic, 6=other (specify)*	b. Minimum Price *(TZS/ unit)*	c. Average Price *(TZS/ unit)*	d. Maximum Price *(TZS/ unit)*
Maize				
Soybean				

4.2.a. How long is an average day of work? *(hours)* ______________________

4.2.b. What is the cost of hiring labor for a day? (*TZS)* ________________________

Section 5: Installation costs

Subsection 5.1: Installation costs

5.1. Please fill in Table 3 with information about the costs associated with the implementation of Crop Rotation or Maize monocropping (costs happening in the first year of the practice)

Table 5.1 : Installation Costs

Category	a. List of items	b. Price per Unit *(TZS/unit)*	Quantity *(# of units)*	
			c. With Intercropping	d. Without Intercropping
1. Machines/ Equipment *1=power tiller, 2= spraying machine, 3=panga, 4=rope, 5=poles, 6=hoe, 7=other (specify).*				
2. Inputs *1=organic fertilizers, 2=inorganic fertilizers, 3=pesticides, 4=fungicides, 5=herbicides, 6=maize seeds, 7=soybean seeds, 8=Rhizobium, 9=other (specify)* *(detail the name of fertilizers and aggregate other prices)*				
3. Services				

1=renting land, 2=renting tiller, 3= renting tractor,4=renting cows, 5=transport, 6=other (specify)				
4. Labor *1=land opening, 2=land preparation, 3= fertilizer application, 4=pesticides spraying, 5=sowing, 6=transplanting, 7=weeding, 8=other (specify)*				

Subsection 5.2: Financial aspect of the installation costs

5.2. Did you receive any loan to finance the installation costs mentioned before? If yes, please fill in table 5.2 with the loans used to finance agricultural expenses.

Table 5.2 : Financial costs associated with installation costs

a. Where did you receive a loan? *(list below)*	b. What did you use the loan for? *(list below)*	c. What is the amount of the loan you took? (*TZS)*	d. When did you receive the loan? *(mm/yy)*	e. When is (was) the last repayment of the loan? *(mm/yy)*	f. What is the total payment you make for the loan? (*TZS)*	What is the interest rate of the loan?	
						g. Interest rate *(%)*	h. Unit

a. **List of institutions**: *1=bank, 2=VSLA/VICOBA, 3=microfinance institutions, 4=Agro dealers, 5=NGO (e.g. OneAcre foundation), 6=friends/relatives, 7=money lenders, 8=mobile money, 9=other (specify)*

b. ***List of items:*** *<u>1. Machines/ Equipment</u>: 1.1=tractor, 1.2=power tiller, 1.3=spraying machine, 1.4=panga, 1.5=rope, 1.6=poles, 1.7=hoe, 1.8=other (specify). <u>2. Inputs:</u> 2.1=organic fertilizers, 2.2=inorganic fertilizers, 2.3=pesticides, 2.4=fungicides, 2.5=herbicides, 2.6=maize seeds, 2.7=soybean seeds, 2.8=other (specify). <u>3. Services</u>: 3.1=renting land, 3.2=renting tiller, 3.3= renting tractor, 3.4=transport, 3.5= other (specify). <u>4. Labor:</u> (4.1=land opening, 4.2=land preparation, 4.3= fertilizer application, 4.4=pesticides spraying, 4.5=sowing, 4.6=transplanting, 4.7=weeding, 4.8=other (specify)*

IMPORTANT: for column b, mark items with * if they were purchased for the CSA practice, **if the loan was used for both practices. <u>Ex:</u> for soybean seeds, write 2.7*

h. **List of units**: *1=monthly, 2=3 monthly, 4=6 monthly, 4=annually, 5=other (specify)*

Section 6: Maintenance costs

Subsection 6.1: Maintenance costs

6.1. Please fill in Table 6.1 with information about the maintenance costs needed when Intercropping is and is not used. Maintenance costs are carried out periodically and are necessary to keep a farming practice working properly over the entire lifetime.

Table 6.1: Maintenance costs

Category	a. Items *(list)*	b. Price per Unit *(TZS/unit)*	Quantity *(# of units)*	
			c. With Intercropping	d. Without Intercropping
1. Machines/ Equipment *1=power tiller, 2= spraying machine, 3=panga, 4=rope, 5=poles, 6=hoe, 7=other (specify).*				
2. Inputs *1=organic fertilizers, 2=inorganic fertilizers, 3=pesticides, 4=fungicides, 5=herbicides, 6=maize seeds, 7=soybean seeds,*				

8=Rhizobium, 9=other (specify) *(detail the name of fertilizers and aggregate other prices)*				
3. Services *1=renting land, 2=renting tiller, 3= renting tractor,4=renting cows, 5=transport, 6=other (specify))*				
4. Labor *1=land opening, 2=land preparation, 3= fertilizer application, 4=pesticides spraying, 5=sowing, 6=transplanting, 7=weeding, 8=other (specify)*				

Subsection 6.2: Financial aspect of the maintenance costs

6.2. Did you receive any loan in addition to (if any) the loans you indicated before to finance the maintenance costs? If yes, please fill in table 6.2 with the loans used to finance agricultural expenses?

Table 6.2 : Financial costs associated with maintenance costs

a. Where did you receive a loan? *(List below)*	b. What did you use the loan for? *(List below)*	c. What is the amount of the loan you took? (*TZS*)	d. When did you receive the loan? *(mm/yy)*	e. When is (was) the last repayment of the loan? *(mm/yy)*	f. What is the total payment you make for the loan? (*TZS*)	What is the interest rate of the loan?	
						g. Interest rate *(%)*	h. Unit

a. **List of institutions**: *1=bank, 2=VSLA/VICOBA, 3=microfinance institutions, 4=Agro dealers, 5=NGO (e.g. OneAcre foundation), 6=friends/relatives, 7=money lenders, 8=mobile money, 9=other (specify)*

b**. *List of items:*** *1. Machines/ Equipment: 1.1=tractor, 1.2=power tiller, 1.3=spraying machine, 1.4=panga, 1.5=rope, 1.6=poles, 1.7= hoe, 1.8=other (specify). 2. Inputs: 2.1=organic fertilizers, 2.2=inorganic fertilizers, 2.3=pesticides, 2.4=fungicides, 2.5=herbicides, 2.6=maize seeds, 2.7=soybean seeds, 2.8=other (specify). 3. Services: 3.1=renting land, 3.2=renting tiller, 3.3= renting tractor, 3.4=transport, 3.5= other (specify). 4. Labor: (4.1=land opening, 4.2=land preparation, 4.3= fertilizer application, 4.4=pesticides spraying, 4.5=sowing, 4.6=transplanting, 4.7=weeding, 4.8=other (specify)*

IMPORTANT: for column b, mark items with * if they were purchased for the CSA practice, **if the loan was used for both practices. Ex: for soybean seeds, write 2.7*

h. **List of units**: *1=monthly, 2=3 monthly, 4=6 monthly, 4=annually, 5=other (specify)*

Section 7: Harvest costs

Subsection 7.1: Harvest costs for Maize

7.1. Please estimate the cost of inputs, services, and labor included in the harvest costs for Maize. Fill in table 7.1 with information.

Table 7.1: Harvest costs, Maize				
Category	a. Item *(list)*	b. Price per Unit *(TZS/unit)*	Quantity *(# of units)*	
			c. With Intercropping	d. Without Intercropping
1. Inputs *1=bags of 130kg, 2=bags of 100kg, 3=plastic, 4=other (specify)*				
2. Labor				

1=harvesting, 2=threshing, 3=cleaning, 4=sorting,5=packaging, 6=other (specify)				
3. Services *1=transport, 2=market fees, 3=taxes, 4=other (specify)*				

Subsection 7.2: Harvest costs for Soybean

7.2. Please estimate the cost of inputs, services, and labor included in the harvest costs of Soybean. Fill in table 7.2 with the information.

Table 7.2: Harvest Costs, Soybean

Category	a. Item *(list)*	b. Price per Unit *(TZS/unit)*	Quantity *(# of units)*	
			c. With Intercropping	d. Without Intercropping
1. Inputs *1=bags of 130kg, 2=bags of 100kg, 3=plastic, 4=other (specify)*				
2. Labor *1=harvesting, 2=threshing, 3=cleaning, 4=sorting,5=packaging, 6=other (specify)*				
3. Services *1=transport, 2=market fees, 3=taxes, 4=other (specify)*				

Subsection 7.3: Financial aspect of the maintenance costs

7.3. Did you receive any loan in addition to (if any) the loans you indicated before to finance the harvest costs? If yes, please fill in table 7.3 with the loans used to finance agricultural expenses.

Table 7.3 : Financial costs associated to harvest costs							
a. Where did you receive a loan? *(List below)*	b. What did you use the loan for? *(List below)*	c. What is the amount of the loan you took? (*TZS*)	d. When did you receive the loan? *(mm/yy)*	e. When is (was) the last repayment of the loan? *(mm/yy)*	f. What is the total payment you make for the loan? (*TZS*)	What is the interest rate of the loan?	
						g. Interest rate *(%)*	h. Unit:

a. **List of institutions**: *1=bank, 2=VSLA/VICOBA, 3=microfinance institutions, 4=Agro dealers, 5=NGO (e.g. OneAcre foundation), 6=friends/relatives, 7=money lenders. 8=mobile money, 9=other (specify)*

*b**. List of items:** <u>1. Machines/ Equipment</u>: 1.1=tractor, 1.2=power tiller, 1.3=spraying machine, 1.4=panga, 1.5=rope, 1.6=poles, 1.7= hoe, 1.8=other (specify). <u>2. Inputs:</u> 2.1=organic fertilizers, 2.2=inorganic fertilizers, 2.3=pesticides, 2.4=fungicides, 2.5=herbicides, 2.6=maize seeds, 2.7=soybean seeds, 2.8=other (specify). <u>3. Services</u>: 3.1=renting land, 3.2=renting tiller, 3.3= renting tractor, 3.4=transport, 3.5= other (specify). <u>4. Labor:</u> (4.1=land opening, 4.2=land preparation, 4.3= fertilizer application, 4.4=pesticides spraying, 4.5=sowing, 4.6=transplanting, 4.7=weeding, 4.8=other (specify)*

IMPORTANT: for column b, mark items with * if they were purchased for the CSA practice, **if the loan was used for both practices. <u>Ex:</u> for soybean seeds, write 2.7*

h. **List of units**: *1=monthly, 2=3 monthly, 4=6 monthly, 4=annually, 5=other (specify)*

Cost-Benefit Analysis, Household Survey

Crop rotation: Maize/Early-maturing soybean

General comments

Thank you for the opportunity to speak with you. We represent CARE Tanzania, in cooperation with the International Center for Tropical Agriculture, Wageningen University & Research and Sokoine University of Agriculture. This questionnaire intends to collect data aimed at helping us to identify farming practices that sustainably increase agricultural productivity and incomes while helping farmers to adapt to changing climate conditions. In addition, the data will help us to understand how Farmer Field & Business Schools (FFBS) and Village Community Bank (VICOBAs) can help farmers to adopt these practices.

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By signing this form, I agree that;

7. I am voluntarily taking part in this survey. I can stop the interview at any time or refuse to answer a question;
8. I don't expect to receive any benefit or payment for my participation;
9. I have been able to ask any questions that I have, and I understand that I am free to contact the researcher with any questions I may have in the future.

Participants name …………………………….. Participants Signature ……………………………...

Date [____/______/_____] (*Date/Month/Year)*

Identification Variables

Key informant Name: ________________________ Household head: _____ (*1=yes, 2=no*)

Age: ______________ Sex: ______ (*1=Male, 2=Female*)

Total land size: __________ (acre)

Enumerator's name: _________________ Questionnaire ID: _______________

Interview start time: _________ Interview end time: ________

Village: ______________________ Ward: __________________

Farmer's phone number: ___________________

Section 1: Farmers Field and Business schools (FFBS)

1. Please fill in table 1 with information about the farmer's participation in FFBS

Table 1 : Farmer's participation in FFBS	
1.1. Is there any farmer field and business school in your village? (*1=yes, 2=no*)	
1.2. Have you or your spouse participated in FFBS activities? (*1=yes, 2=no*)	
1.3. How many times since the beginning of the project? (*1= once or twice, 2= 3 to 4 times, 3= 5 to 10 times, 4= More than 10 times*)	
1.4 Did the participant learn how to practice the maize – soybean rotation at the FFBS? (*1=yes, 2=no*)	

Section 2: Characterizing Crop rotation versus Maize monocropping (business as usual).

2.0. Do you still practice maize monocropping? (*1=yes, 2=no*) _______________

2. In table 2, please describe the two practices.

Table 2 : Characterizing Crop rotation and Maize monocropping		
	a. Crop rotation	b. Maize monocropping
2.1.i. Maize spacing *Row spacing*plant spacing (cm)*		
2.1.ii. Maize sowing month		
2.1.iii. Maize harvesting month		
2.1.iv. Soybean spacing *Row spacing*plant spacing (cm)*		

2.1.v. Soybean sowing month			
2.1.vi. Soybean harvesting month			
2.2. Please specify which maize varieties you cultivate			
2.3. Please specify which soybean varieties you cultivate *Soybean: 1=safari, 2=yuole 2, 3=spike, 4=yuole 4, 5=other (specify)*	i. Last year	ii. This year	
2.4. What is the total land size you use for each practice? *(acre)*			
2.5. What is the land size you use to cultivate maize in rotation?			
2.6. What is the land size you use to cultivate soybean in rotation?			
2.7. When did you start using these practices? *1=this season, 2=2 seasons ago, 3=3 seasons ago, 4=4 seasons ago, and so on.*			
2.8. How long do you intend to use this practice? *1=1 more season, 2=2 more seasons, 3=3 more seasons, 4=4 more seasons and so on.*			

Section 3: Changes in productivity

Subsection 3.1: Shape of the physical response

3.3. If possible, please describe the evolution of the yield when using Crop rotation

Table 3.1 : Expected evolution of the yield with Crop rotation

Crop	a. How many years pass before you begin to see a change in the yield (compared with the BAU)?	b. How many years pass before the yield reaches its maximum with this practice?	c. What is the maximum harvest you expect to reach with this practice? *(number of units)*	d. Unit of harvest *1=kg, 2=bag of 130kg, 3=bag of 100kg, 4=bags of seven plastics, 5=plastic, 6=other (specify)*
1. Maize				
2. Soybean				

Subsection 3.2: Expected harvest with Crop rotation

3.2. Please fill in the table 3.2 with the ouputs you got last year and these that can be expected given the cultivated areas provided in question 2.4 to 2.6, when **<u>using</u>** Crop rotation, for each crop.

Table 3.2 : Harvest with Crop rotation					
After introducing Crop rotation….					
Crop	a. what harvest did you get at the end of last year?	b. what is the expected minimum harvest at the end of this year?	c. what is the expected average harvest at the end of this year?	d. what is the expected maximum harvest at the end of this year?	e. Unit of harvest *1=kg, 2=bag of 130kg, 3=bag of 100kg, 4=bags of seven plastics, 5=plastic, 6=other (specify)*
1. Maize					
2. Soybean					

Subsection 3.3: Expected harvest **<u>without</u>** Crop rotation

3.3. Please fill in the table 3.3 with the outputs that can be expected given the cultivated area provided in question 2.4, when **<u>not using</u>** Crop rotation, for each crop.

Table 3.3: Harvest <u>without</u> Crop rotation				
If Crop rotation is **<u>not</u>** used, what is the estimated…				
Crop	a. expected minimum harvest?	b. expected average harvest?	c. expected maximum harvest?	d. Unit of harvest *1=kg, 2=bag of 130kg, 3=bag of 100kg, 4=bags of seven plastics, 5=plastic, 6=other (specify)*
Maize				

Section 4: Prices at farm level

4.1. Please fill the table 4 with the different measurement units and corresponding prices for each crop.

Table 4 : Pricing and price variability at farm level				
Crop	a. Units *1=kg, 2=bag of 130kg, 3=bag of 100kg, 4=bags of seven plastics, 5=plastic, 6=other (specify)*	b. Minimum Price *(TZS/ unit)*	c. Average Price *(TZS/ unit)*	d. Maximum Price *(TZS/ unit)*
1. Maize				
2. Soybean				

4.2.a. How long is an average day of work? *(hours)* ______________________

4.2.b. What is the cost of hiring labor for a day? (*TZS*) _______________________

Section 5: Installation costs

Subsection 5.1: Installation costs

5.1. Please fill in Table 5.1 with information about the costs associated with the implementation of Crop Rotation or Maize monocropping (costs happening in the first year of the practice)

Table 5.1 : Installation Costs				
Category	a. List of items	b. Price per Unit *(TZS/unit)*	Quantity *(# of units)*	
			c. With Crop rotation	d. Without Crop rotation
1. Machines/ Equipment *1=power tiller, 2= spraying machine, 3=panga, 4=rope, 5=poles, 6=hoe, 7=other (specify).*				

2. Inputs *1=organic fertilizers, 2=inorganic fertilizers, 3=pesticides, 4=fungicides, 5=herbicides, 6=maize seeds, 7=soybean seeds, 8=Rhizobium, 9=other (specify)* *(detail the name of fertilizers and aggregate other prices)*				
3. Services *1=renting land, 2=renting tiller, 3=renting tractor, 4=renting cows, 5=transport, 6=other (specify)*				
4. Labor *1=land opening, 2=land preparation, 3= fertilizer application, 4=pesticides spraying, 5=sowing, 6=transplanting, 7=weeding, 8=other (specify)*				

Subsection 5.2: Financial aspect of the installation costs

5.2. Did you receive any loan to finance the installation costs mentioned before? If yes, please fill in table 5.2 with the loans used to finance agricultural expenses.

Table 5.2 : Financial costs associated with installation costs							
a. Where did you receive a loan? *(list below)*	b. What did you use the loan for? *(list below)*	c. What is the amount of the loan you took? (*TZS)*	d. When did you receive the loan? *(mm/yy)*	e. When is (was) the last repayment of the loan? *(mm/yy)*	f. What is the total payment you make for the loan? (*TZS)*	What is the interest rate of the loan?	
						g. Interest rate *(%)*	h. Unit

a. **List of institutions**: *1=bank, 2=VSLA/VICOBA, 3=microfinance institutions, 4=Agro dealers, 5=NGO (e.g. OneAcre foundation), 6=friends/relatives, 7=money lenders, 8=mobile money, 9=other (specify)*

*b**. List of items:** 1. Machines/ Equipment: 1.1=tractor, 1.2=power tiller, 1.3=spraying machine, 1.4=panga, 1.5=rope, 1.6=poles, 1.7=hoe, 1.8=other (specify). 2. Inputs: 2.1=organic fertilizers, 2.2=inorganic fertilizers, 2.3=pesticides, 2.4=fungicides, 2.5=herbicides, 2.6=maize seeds, 2.7=soybean seeds, 2.8=other (specify). 3. Services: 3.1=renting land, 3.2=renting tiller, 3.3= renting tractor, 3.4=transport, 3.5= other (specify). 4. Labor: (4.1=land opening, 4.2=land preparation, 4.3= fertilizer application, 4.4=pesticides spraying, 4.5=sowing, 4.6=transplanting, 4.7=weeding, 4.8=other (specify)*

IMPORTANT: for column b, mark items with * if they were purchased for the CSA practice, **if the loan was used for both practices. Ex: for soybean seeds, write 2.7*

h. **List of units**: *1=monthly, 2=3 monthly, 4=6 monthly, 4=annually, 5=other (specify)*

Section 6: Maintenance costs

Subsection 6.1: Maintenance costs

6.1. Please fill in Table 6.1 with information about the maintenance costs needed when Crop rotation is and is not used. Maintenance costs are carried out periodically and are necessary to keep a farming practice working properly over the entire lifetime.

Table 6.1: Maintenance costs				
Category	a. Items *(list)*	b. Price per Unit *(TZS/unit)*	Quantity *(# of units)*	
			c. With Crop rotation	d. Without Crop rotation
1. Machines/ Equipment *1=power tiller, 2= spraying machine, 3=panga, 4=rope, 5=poles, 6=hoe, 7=other (specify).*				
2. Inputs *1=organic fertilizers, 2=inorganic fertilizers, 3=pesticides, 4=fungicides, 5=herbicides, 6=maize seeds, 7=soybean seeds, 8=Rhizobium, 9=other (specify)* *(detail the name of fertilizers and aggregate other prices)*				
3. Services *1=renting land, 2=renting tiller, 3= renting tractor,4=renting cows, 5=transport, 6=other (specify))*				
4. Labor *1=land opening, 2=land preparation, 3= fertilizer application, 4=pesticides spraying, 5=sowing, 6=transplanting, 7=weeding, 8=other (specify)*				

Subsection 6.2: Financial aspect of the maintenance costs

6.2. Did you receive any loan in addition to (if any) the loans you indicated before to finance the maintenance costs? If yes, please fill in table 6.2 with the loans used to finance agricultural expenses?

Table 6.2 : Financial costs associated with maintenance costs							
a. Where did you receive a loan? *(List below)*	b. What did you use the loan for? *(List below)*	c. What is the amount of the loan you took? (*TZS)*	d. When did you receive the loan? *(mm/yy)*	e. When is (was) the last repayment of the loan? *(mm/yy)*	f. What is the total payment you make for the loan? (*TZS)*	What is the interest rate of the loan?	
						g. Interest rate *(%)*	h. Unit

a. **List of institutions**: *1=bank, 2=VSLA/VICOBA, 3=microfinance institutions, 4=Agro dealers, 5=NGO (e.g. OneAcre foundation), 6=friends/relatives, 7=money lenders, 8=mobile money, 9=other (specify)*

*b**. List of items:** 1. Machines/ Equipment: 1.1=tractor, 1.2=power tiller, 1.3=spraying machine, 1.4=panga, 1.5=rope, 1.6=poles, 1.7= hoe, 1.8=other (specify). 2. Inputs: 2.1=organic fertilizers, 2.2=inorganic fertilizers, 2.3=pesticides, 2.4=fungicides, 2.5=herbicides, 2.6=maize seeds, 2.7=soybean seeds, 2.8=other (specify). 3. Services: 3.1=renting land, 3.2=renting tiller, 3.3= renting tractor, 3.4=transport, 3.5= other (specify). 4. Labor: (4.1=land opening, 4.2=land preparation, 4.3= fertilizer application, 4.4=pesticides spraying, 4.5=sowing, 4.6=transplanting, 4.7=weeding, 4.8=other (specify)*

IMPORTANT: for column b, mark items with * if they were purchased for the CSA practice, **if the loan was used for both practices. Ex: for soybean seeds, write 2.7*

h. **List of units**: *1=monthly, 2=3 monthly, 4=6 monthly, 4=annually, 5=other (specify)*

Section 7: Harvest costs

Subsection 7.1: Harvest costs for Maize

7.1. Please estimate the cost of inputs, services, and labor included in the harvest costs for Maize. Fill in table 7.1 with information.

Table 7.1: Harvest costs, Maize				
Category	a. Item *(list)*	b. Price per Unit *(TZS/unit)*	Quantity *(# of units)*	
			c. With Crop rotation	d. Without Crop rotation
1. Inputs *1=bags of 130kg, 2=bags of 100kg, 3=plastic, 4=other (specify)*				
2. Labor *1=harvesting, 2=threshing, 3=cleaning, 4=sorting,5=packaging, 6=other (specify)*				
3. Services *1=transport, 2=market fees, 3=taxes, 4=other (specify)*				

Subsection 7.2: Harvest costs for Soybean

7.2. Please estimate the cost of inputs, services, and labor included in the harvest costs of Soybean. Fill in table 7.2 with the information.

Table 7.2: Harvest Costs, Soybean				
Category	a. Item *(list)*	b. Price per Unit *(TZS/unit)*	Quantity *(# of units)*	
			c. With Crop rotation	d. Without Crop rotation

1. Inputs *1=bags of 130kg, 2=bags of 100kg, 3=plastic, 4=other (specify)*				
2. Labor *1=harvesting, 2=threshing, 3=cleaning, 4=sorting,5=packaging, 6=other (specify)*				
3. Services *1=transport, 2=market fees, 3=taxes, 4=other (specify)*				

Subsection 7.3: Financial aspect of the harvest costs

7.3. Did you receive any loan in addition to (if any) the loans you indicated before to finance the harvest costs? If yes, please fill in table 7.3 with the loans used to finance agricultural expenses.

Table 7.3 : Financial costs associated with harvest costs

a. Where did you receive a loan? *(List below)*	b. What did you use the loan for? *(List below)*	c. What is the amount of the loan you took? (*TZS)*	d. When did you receive the loan? *(mm/yy)*	e. When is (was) the last repayment of the loan? *(mm/yy)*	f. What is the total payment you make for the loan? (*TZS)*	What is the interest rate of the loan?	
						g. Interest rate *(%)*	h. Unit:

a. **List of institutions**: *1=bank, 2=VSLA/VICOBA, 3=microfinance institutions, 4=Agro dealers, 5=NGO (e.g. OneAcre foundation), 6=friends/relatives, 7=money lenders. 8=mobile money, 9=other (specify)*

*b**. List of items:*** *1. Machines/ Equipment: 1.1=tractor, 1.2=power tiller, 1.3=spraying machine, 1.4=panga, 1.5=rope, 1.6=poles, 1.7= hoe, 1.8=other (specify). 2. Inputs: 2.1=organic fertilizers, 2.2=inorganic fertilizers, 2.3=pesticides, 2.4=fungicides, 2.5=herbicides, 2.6=maize seeds, 2.7=soybean seeds, 2.8=other (specify). 3. Services: 3.1=renting land, 3.2=renting tiller, 3.3= renting tractor, 3.4=transport, 3.5= other (specify). 4. Labor: (4.1=land opening, 4.2=land preparation, 4.3= fertilizer application, 4.4=pesticides spraying, 4.5=sowing, 4.6=transplanting, 4.7=weeding, 4.8=other (specify)*

IMPORTANT: for column b, mark items with * if they were purchased for the CSA practice, **if the loan was used for both practices. Ex: for soybean seeds, write 2.7*

h. **List of units**: *1=monthly, 2=3 monthly, 4=6 monthly, 4=annually, 5=other (specify)*

Cost-Benefit Analysis, Household Survey

Crop rotation: Maize/Late-maturing soybean

General comments

Thank you for the opportunity to speak with you. We represent CARE Tanzania, in cooperation with the International Center for Tropical Agriculture, Wageningen University & Research and Sokoine University of Agriculture. This questionnaire intends to collect data aimed at helping us to identify farming practices that sustainably increase agricultural productivity and incomes while helping farmers to adapt to changing climate conditions. In addition, the data will help us to understand how Farmer Field & Business Schools (FFBS) and Village Community Bank (VICOBAs) can help farmers to adopt these practices.

We are now collecting information to understand the costs and the benefits associated with the use of a maize/late-maturing soybean rotation in comparison with maize monocropping. This survey will help us understand how profitable it is for farmers, and the role of FFBS and VICOBASs in adopting this practice. The respondents for this survey shall be decision makers regarding production and other agricultural activities in the household, and must be at least 18 years old. Participation in this survey is voluntary. Information obtained is strictly for academic and research purposes and responses obtained will be confidential. This interview is voluntary and will take approximately one and a half hour. Your participation will be highly appreciated.

By signing this form, I agree that;

10. I am voluntarily taking part in this survey. I can stop the interview at any time or refuse to answer a question;
11. I don't expect to receive any benefit or payment for my participation;
12. I have been able to ask any questions that I have, and I understand that I am free to contact the researcher with any questions I may have in the future.

Participants name …………………………….. Participants Signature ……………………………...

Date [____/______/_____] (*Date/Month/Year)*

Identification Variables

Key informant Name: _______________________ Household head: _____ (*1=yes, 2=no*)

Age: _____________ Sex: ______ (*1=Male, 2=Female*)

Total land size: __________ (acre)

Enumerator's name: ________________ Questionnaire ID: ______________

Interview start time: _________ Interview end time: ________

Village: _____________________ Ward: _________________

Farmer's phone number: __________________

Section 1: Farmers Field and Business schools (FFBS)

1. Please fill in table 1 with information about the farmer's participation in FFBS

Table 1 : Farmer's participation in FFBS	
1.1. Is there any farmer field and business school in your village? (*1=yes, 2=no*)	
1.2. Have you or your spouse participated in FFBS activities? (*1=yes, 2=no*)	
1.3. How many times since the beginning of the project? (*1= once or twice, 2= 3 to 4 times, 3= 5 to 10 times, 4= More than 10 times*)	
1.4 Did the participant learn how to practice the maize – soybean rotation at the FFBS? (*1=yes, 2=no*)	

Section 2: Characterizing Crop rotation versus Maize monocropping (business as usual).

2.0. Do you still practice maize monocropping? (*1=yes, 2=no*) _______________

2. In table 2, please describe the two practices.

Table 2 : Characterizing Crop rotation and Maize monocropping		
	a. Crop rotation	b. Maize monocropping
2.1.i. Maize spacing *Row spacing*plant spacing (cm)*		
2.1.ii. Maize sowing month		
2.1.iii. Maize harvesting month		
2.1.iv. Soybean spacing *Row spacing*plant spacing (cm)*		

2.1.v. Soybean sowing month			
2.1.vi. Soybean harvesting month			
2.2. Please specify which maize varieties you cultivate			
2.3. Please specify which soybean varieties you cultivate *Soybean: 1=safari, 2=yuole 2, 3=spike, 4=yuole 4, 5=other (specify)*	i. Last year	ii. This year	
2.4. What is the total land size you use for each practice? *(acre)*			
2.5. What is the land size you use to cultivate maize in rotation?			
2.6. What is the land size you use to cultivate soybean in rotation?			
2.7. When did you start using these practices? *1=this season, 2=2 seasons ago, 3=3 seasons ago, 4=4 seasons ago, and so on.*			
2.8. How long do you intend to use this practice? *1=1 more season, 2=2 more seasons, 3=3 more seasons, 4=4 more seasons and so on.*			

Section 3: Changes in productivity

Subsection 3.1: Shape of the physical response

3.3. If possible, please describe the evolution of the yield when using Crop rotation

Table 3.1 : Expected evolution of the yield with Crop rotation

Crop	a. How many years pass before you begin to see a change in the yield (compared with the BAU)?	b. How many years pass before the yield reaches its maximum with this practice?	c. What is the maximum harvest you expect to reach with this practice? *(number of units)*	d. Unit of harvest *1=kg, 2=bag of 130kg, 3=bag of 100kg, 4=bags of seven plastics, 5=plastic, 6=other (specify)*
1. Maize				
2. Soybean				

Subsection 3.2: Expected harvest with Crop rotation

3.2. Please fill in the table 3.2 with the ouputs you got last year and these that can be expected given the cultivated areas provided in question 2.4 to 2.6, when **<u>using</u>** Crop rotation, for each crop.

Table 3.2 : Harvest with Crop rotation					
After introducing Crop rotation….					
Crop	a. what harvest did you get at the end of last year?	b. what is the expected minimum harvest at the end of this year?	c. what is the expected average harvest at the end of this year?	d. what is the expected maximum harvest at the end of this year?	e. Unit of harvest *1=kg, 2=bag of 130kg, 3=bag of 100kg, 4=bags of seven plastics, 5=plastic, 6=other (specify)*
1. Maize					
2. Soybean					

Subsection 3.3: Expected harvest **<u>without</u>** Crop rotation

3.3. Please fill in the table 3.3 with the outputs that can be expected given the cultivated area provided in question 2.4, when **<u>not using</u>** Crop rotation, for each crop.

Table 3.3: Harvest <u>without</u> Crop rotation				
If Crop rotation is **<u>not</u>** used, what is the estimated…				
Crop	a. expected minimum harvest?	b. expected average harvest?	c. expected maximum harvest?	d. Unit of harvest *1=kg, 2=bag of 130kg, 3=bag of 100kg, 4=bags of seven plastics, 5=plastic, 6=other (specify)*
Maize				

Section 4: Prices at farm level

4.1. Please fill the table 4 with the different measurement units and corresponding prices for each crop.

Table 4 : Pricing and price variability at farm level				
Crop	a. Units *1=kg, 2=bag of 130kg, 3=bag of 100kg, 4=bags of seven plastics, 5=plastic, 6=other (specify)*	b. Minimum Price *(TZS/ unit)*	c. Average Price *(TZS/ unit)*	d. Maximum Price *(TZS/ unit)*
1. Maize				
2. Soybean				

4.2.a. How long is an average day of work? *(hours)* ______________________

4.2.b. What is the cost of hiring labor for a day? (*TZS)* _______________________

Section 5: Installation costs

Subsection 5.1: Installation costs

5.1. Please fill in Table 5.1 with information about the costs associated with the implementation of Crop Rotation or Maize monocropping (costs happening in the first year of the practice)

Table 5.1 : Installation Costs				
Category	a. List of items	b. Price per Unit *(TZS/unit)*	Quantity *(# of units)*	
			c. With Crop rotation	d. Without Crop rotation
1. Machines/ Equipment *1=power tiller, 2= spraying machine, 3=panga, 4=rope, 5=poles, 6=hoe, 7=other (specify).*				

2. Inputs *1=organic fertilizers, 2=inorganic fertilizers, 3=pesticides, 4=fungicides, 5=herbicides, 6=maize seeds, 7=soybean seeds, 8=Rhizobium, 9=other (specify)* *(detail the name of fertilizers and aggregate other prices)*				
3. Services *1=renting land, 2=renting tiller, 3=renting tractor, 4=renting cows, 5=transport, 6=other (specify)*				
4. Labor *1=land opening, 2=land preparation, 3= fertilizer application, 4=pesticides spraying, 5=sowing, 6=transplanting, 7=weeding, 8=other (specify)*				

Subsection 5.2: Financial aspect of the installation costs

5.2. Did you receive any loan to finance the installation costs mentioned before? If yes, please fill in table 5.2 with the loans used to finance agricultural expenses.

Table 5.2 : Financial costs associated with installation costs							
a. Where did you receive a loan? *(list below)*	b. What did you use the loan for? *(list below)*	c. What is the amount of the loan you took? (*TZS)*	d. When did you receive the loan? *(mm/yy)*	e. When is (was) the last repayment of the loan? *(mm/yy)*	f. What is the total payment you make for the loan? (*TZS)*	What is the interest rate of the loan?	
						g. Interest rate *(%)*	h. Unit

a. **List of institutions**: *1=bank, 2=VSLA/VICOBA, 3=microfinance institutions, 4=Agro dealers, 5=NGO (e.g. OneAcre foundation), 6=friends/relatives, 7=money lenders, 8=mobile money, 9=other (specify)*

*b**. List of items:** 1. Machines/ Equipment: 1.1=tractor, 1.2=power tiller, 1.3=spraying machine, 1.4=panga, 1.5=rope, 1.6=poles, 1.7=hoe, 1.8=other (specify). 2. Inputs: 2.1=organic fertilizers, 2.2=inorganic fertilizers, 2.3=pesticides, 2.4=fungicides, 2.5=herbicides, 2.6=maize seeds, 2.7=soybean seeds, 2.8=other (specify). 3. Services: 3.1=renting land, 3.2=renting tiller, 3.3= renting tractor, 3.4=transport, 3.5= other (specify). 4. Labor: (4.1=land opening, 4.2=land preparation, 4.3= fertilizer application, 4.4=pesticides spraying, 4.5=sowing, 4.6=transplanting, 4.7=weeding, 4.8=other (specify)*

IMPORTANT: for column b, mark items with * if they were purchased for the CSA practice, **if the loan was used for both practices. Ex: for soybean seeds, write 2.7*

h. **List of units**: *1=monthly, 2=3 monthly, 4=6 monthly, 4=annually, 5=other (specify)*

Section 6: Maintenance costs

Subsection 6.1: Maintenance costs

6.1. Please fill in Table 6.1 with information about the maintenance costs needed when Crop rotation is and is not used. Maintenance costs are carried out periodically and are necessary to keep a farming practice working properly over the entire lifetime.

Table 6.1: Maintenance costs				
Category	a. Items *(list)*	b. Price per Unit *(TZS/unit)*	Quantity *(# of units)*	
			c. With Crop rotation	d. Without Crop rotation
1. Machines/ Equipment *1=power tiller, 2= spraying machine, 3=panga, 4=rope, 5=poles, 6=hoe, 7=other (specify).*				
2. Inputs *1=organic fertilizers, 2=inorganic fertilizers, 3=pesticides, 4=fungicides, 5=herbicides, 6=maize seeds, 7=soybean seeds, 8=Rhizobium, 9=other (specify)* *(detail the name of fertilizers and aggregate other prices)*				
3. Services *1=renting land, 2=renting tiller, 3= renting tractor,4=renting cows, 5=transport, 6=other (specify))*				
4. Labor *1=land opening, 2=land preparation, 3= fertilizer application, 4=pesticides spraying, 5=sowing, 6=transplanting, 7=weeding, 8=other (specify)*				

Subsection 6.2: Financial aspect of the maintenance costs

6.2. Did you receive any loan in addition to (if any) the loans you indicated before to finance the maintenance costs? If yes, please fill in table 6.2 with the loans used to finance agricultural expenses?

Table 6.2 : Financial costs associated with maintenance costs

a. Where did you receive a loan? *(List below)*	b. What did you use the loan for? *(List below)*	c. What is the amount of the loan you took? (*TZS*)	d. When did you receive the loan? *(mm/yy)*	e. When is (was) the last repayment of the loan? *(mm/yy)*	f. What is the total payment you make for the loan? (*TZS*)	What is the interest rate of the loan?	
						g. Interest rate *(%)*	h. Unit

a. **List of institutions**: *1=bank, 2=VSLA/VICOBA, 3=microfinance institutions, 4=Agro dealers, 5=NGO (e.g. OneAcre foundation), 6=friends/relatives, 7=money lenders, 8=mobile money, 9=other (specify)*

*b**. List of items:** 1. Machines/ Equipment: 1.1=tractor, 1.2=power tiller, 1.3=spraying machine, 1.4=panga, 1.5=rope, 1.6=poles, 1.7= hoe, 1.8=other (specify). 2. Inputs: 2.1=organic fertilizers, 2.2=inorganic fertilizers, 2.3=pesticides, 2.4=fungicides, 2.5=herbicides, 2.6=maize seeds, 2.7=soybean seeds, 2.8=other (specify). 3. Services: 3.1=renting land, 3.2=renting tiller, 3.3= renting tractor, 3.4=transport, 3.5= other (specify). 4. Labor: (4.1=land opening, 4.2=land preparation, 4.3= fertilizer application, 4.4=pesticides spraying, 4.5=sowing, 4.6=transplanting, 4.7=weeding, 4.8=other (specify)*

IMPORTANT: for column b, mark items with * if they were purchased for the CSA practice, **if the loan was used for both practices. Ex: for soybean seeds, write 2.7*

h. **List of units**: *1=monthly, 2=3 monthly, 4=6 monthly, 4=annually, 5=other (specify)*

Section 7: Harvest costs

Subsection 7.1: Harvest costs for Maize

7.1. Please estimate the cost of inputs, services, and labor included in the harvest costs for Maize. Fill in table 7.1 with information.

Table 7.1: Harvest costs, Maize

Category	a. Item *(list)*	b. Price per Unit *(TZS/unit)*	Quantity *(# of units)*	
			c. With Crop rotation	d. Without Crop rotation
1. Inputs *1=bags of 130kg, 2=bags of 100kg, 3=plastic, 4=other (specify)*				
2. Labor *1=harvesting, 2=threshing, 3=cleaning, 4=sorting,5=packaging, 6=other (specify)*				
3. Services *1=transport, 2=market fees, 3=taxes, 4=other (specify)*				

Subsection 7.2: Harvest costs for Soybean

7.2. Please estimate the cost of inputs, services, and labor included in the harvest costs of Soybean. Fill in table 7.2 with the information.

Table 7.2: Harvest Costs, Soybean				
Category	a. Item *(list)*	b. Price per Unit *(TZS/unit)*	Quantity *(# of units)*	
			c. With Crop rotation	d. Without Crop rotation
1. Inputs *1=bags of 130kg, 2=bags of 100kg, 3=plastic, 4=other (specify)*				
2. Labor *1=harvesting, 2=threshing, 3=cleaning, 4=sorting,5=packaging, 6=other (specify)*				
3. Services *1=transport, 2=market fees, 3=taxes, 4=other (specify)*				

Subsection 7.3: Financial aspect of the harvest costs

7.3. Did you receive any loan in addition to (if any) the loans you indicated before to finance the harvest costs? If yes, please fill in table 7.3 with the loans used to finance agricultural expenses.

Table 7.3 : Financial costs associated with harvest costs						
a. Where did you receive a loan?		c. What is the amount of the loan	d. When did you receive the loan?	e. When is (was) the last repayment of the loan?	f. What is the total payment you make	What is the interest rate of the loan?

(List below)	b. What did you use the loan for? *(List below)*	you took? *(TZS)*	*(mm/yy)*	*(mm/yy)*	for the loan? *(TZS)*	g. Interest rate *(%)*	h. Unit:

a. **List of institutions**: *1=bank, 2=VSLA/VICOBA, 3=microfinance institutions, 4=Agro dealers, 5=NGO (e.g. OneAcre foundation), 6=friends/relatives, 7=money lenders. 8=mobile money, 9=other (specify)*

*b**. List of items:** 1. Machines/ Equipment: 1.1=tractor, 1.2=power tiller, 1.3=spraying machine, 1.4=panga, 1.5=rope, 1.6=poles, 1.7= hoe, 1.8=other (specify). 2. Inputs: 2.1=organic fertilizers, 2.2=inorganic fertilizers, 2.3=pesticides, 2.4=fungicides, 2.5=herbicides, 2.6=maize seeds, 2.7=soybean seeds, 2.8=other (specify). 3. Services: 3.1=renting land, 3.2=renting tiller, 3.3= renting tractor, 3.4=transport, 3.5= other (specify). 4. Labor: (4.1=land opening, 4.2=land preparation, 4.3= fertilizer application, 4.4=pesticides spraying, 4.5=sowing, 4.6=transplanting, 4.7=weeding, 4.8=other (specify)*

IMPORTANT: for column b, mark items with * if they were purchased for the CSA practice, **if the loan was used for both practices. Ex: for soybean seeds, write 2.7*

h. **List of units**: *1=monthly, 2=3 monthly, 4=6 monthly, 4=annually, 5=other (specify)*

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