Farmer Field Business Schools and Village Savings and Loan Associations for promoting climate-smart agriculture practices: Evidence from rural Tanzania

Working Paper No. 361

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

Haki Pamuk
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Contact us
CCAFS Program Management Unit, Wageningen University & Research, Lumen building, Droevendaalsesteeg 3a, 6708 PB Wageningen, the Netherlands. Email: ccafs@cgiar.org

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Abstract

We use quasi-experimental data collected in Iringa Tanzania to investigate the impact of a community based approach to promote the adoption of climate smart agriculture (CSA) practices. Based on two community-based organizations, Farmer Field Business Schools (FFBS) and Village Savings and Loan Associations (VSLAs), this approach combines interventions on farmer training, access to microfinance, and women's empowerment in agriculture to introduce and enhance the adoption of the practices. We find a positive effect of the interventions on the adoption rates of CSA practices, including mulching, manure composting, crop rotation and rhizobium inoculation, and soybean production. This effect was more pronounced for farmers that participated in the trainings provided by the FFBSs and members of VSLAs. Farming households scoring high in terms of women's empowerment are also more likely to adopt the introduced practices when compared to those scoring low. We also find that increased soybean production results in increased soybean sales and consumption, showing the contribution of the interventions to the incomes and nutrition levels of the farmers. These results show that FFBS and VSLA serve as promising community based platforms to introduce interventions on farmers training, microfinance, women's empowerment to upscale the adoption of CSA practices.

Keywords

Farmer Field Business Schools; Village Savings and Loan Associations; technology adoption, credit; saving; women's empowerment; farmer training; climate-smart agriculture.

About the authors

Haki Pamuk, Wageningen University and Research, Development Economics Group and Wageningen Economic Research, P.O. Box 35, 6700 AA Wageningen, The Netherlands. haki.pamuk@wur.nl. Corresponding author.

Marcel van Asseldonk, Wageningen University and Research, Wageningen Economic Research, P.O. Box 35, 6700 AA Wageningen, The Netherlands.

Cor Wattel, Wageningen University and Research, Wageningen Economic Research, P.O. Box 35, 6700 AA Wageningen, The Netherlands.

Stanley Karanja Ng'ang'a. Alliance of Bioversity International and CIAT Africa Hub Kasarani, Rd., ICIPE Complex, PO Box 823-00621, Nairobi, Kenya.

Joseph Philip Hella, Sokoine University of Agriculture, Department of Food and Natural Resources in Sokoine University of Agriculture (SUA) in Tanzania. Tel. + 255 655 787777. P.O. Box 3007, Chuo Kikuu, Morogoro.

Ruerd Ruben, Wageningen University and Research, The Netherlands. Wageningen Economic Research and Development Economics Group, P.O. Box 35, 6700 AA Wageningen, The Netherlands.

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Contents

1 Introduction

How can stakeholders (e.g., governments and their extension services, private sector, policy makers and NGOs) effectively stimulate the adoption of climate-smart agricultural (CSA) practices among small-scale farmers in developing countries? Changes in temperatures and rainfall lead to new risks of drought as well as erratic and excess rainfall (Ericksen et al., 2011; WMO, 2020). Many farmers experience climate change as a threat since crop yields that farmers needed to sustain themselves are adversely affected (IPCC, 2014; WMO, 2020). At the same time, the agricultural sector also contributes to climate change since agricultural greenhouse gas (GHG) emissions (nitrous oxide, methane, and carbon dioxide) are among the significant drivers of global warming (CCAFS, 2021).

CSA is an approach that guides actions in transforming and re-orienting agricultural systems to efficiently support the development and ensure food security in a changing climate (FAO, 2013). CSA thus aims to achieve three objectives simultaneously: helping farmers adapt to climate change and improving their resilience to climate change, reducing or removing GHG emissions where appropriate and enhancing farmers' agricultural productivity. CSA provides the means to help stakeholders at all levels (e.g., local, national, and international) pinpoint agricultural strategies suitable for their local conditions. Among many other capacity-building interventions, the approach also involves the identification and adoption of a wide range of agricultural practices, such as more drought-resilient seeds and breeds, improved agronomic and livestock management practices, soil and water management, agroforestry, diversification of crops and institutional innovations (CCAFS, 2021, FAO, 2013).

Upscaling CSA practices among small-scale farmers in developing countries have been a challenging endeavour (Westermann et al., 2015). Those small-scale farmers face barriers to adoption, linked to limited farming knowledge (Juana et al., 2013) and innovation skills (Klerkx et al., 2013), behavioural barriers (e.g., risk perceptions and attitudes, harmful social and gender norms) (Nigussie, 2017, Jellason, 2021), and constrained access to finance (Sadler, 2016, Ruben et al., 2018) to invest in inputs necessary for the implementation of the practices. Still, problems also arise related to agro-ecology (Andrieu & Kebede, 2020), markets (Sloan et al., 2019) and institutions (Agrawal, 2008). These barriers are higher for the small-scale farmers in developing than developed countries (Yohannes, 2016) and especially female farmers who are more disadvantaged in, for example, access to knowledge, finance, and markets (Bryan, 2017), showing the weakness of the CSA approach to address the climate challenges of farmers in an equal way.

This paper studies how a community based approach that combines farmer training, access to microfinance, and women's empowerment in agriculture can contribute to the adoption of CSA practices of small-scale farmers in developing countries. This approach combines two community-based organizations, namely Farmer Field and Business Schools (FFBS) and Village Savings and Loan Associations (VSLAs), designed to remove barriers to knowledge and finance for small-scale rural farmers in developing countries and contribute to gender equality.

FFBS is a participatory, extension approach that helps farmers build skills necessary to improve production, acquire nutrition knowledge, access markets, and sell at competitive prices, and engage in beneficial and informed decision-making. It aims to change gender relations to make women farmers successful, businesspeople, and leaders (CARE, 2017a). Evaluations testing the effects of farmer fields schools show that these schools increase the adoption rate of good agricultural practices, contribute to the increase in yields and income of farmers, and reduce environmental degradation (see Waddington et al. (2014) for a review).

A VSLA is a self-managed group of 20-30 individuals, mostly women, which meets regularly to provide its members with a safe place to save their money, access loans, and obtain emergency insurance, and a platform for building social capital, which is key for collective advocacy (CARE, 2017b). The evidence from randomized control trials studies on the effects of VSLA is mixed. The evidence from Ghana, Malawi, and Uganda shows that VSLAs empower women and help them to improve their business outcomes. However, they have not increased household food security, income, and assets (Karlan et al., 2017). Yet other evidence from Malawi (Ksoll et al., 2016) reveals that VSLA improves household food security and expenditure through increased agricultural investment financed by savings and loans accessed through VSLAs.

We specifically investigate and test the impact pathway of the FFBS approach combined with the VLSA approach (FFBS+VSLA hereon) to promote the adoption of CSA practices of small-scale farmers in developing countries, addressing the lack of agricultural and business knowledge and access to finance as well as empowering women. For this purpose, we use a case study from the Iringa Region in Tanzania. Tanzania presents very suitable conditions for agriculture, but at the same time, it is highly vulnerable to climate variability and change (CIAT/CARE Tanzania, 2019). In the Iringa region, CARE-Tanzania has implemented a four-year project. The project introduces FFBSs that train mostly female farmers to adopt CSA practices, specifically soybean cultivation, mulching, intercropping, crop rotation, manure application and rhizobium inoculation methods and contribute to the transformation of gender norms through gender training to the couples. The project also improves the functioning of VSLAs and encourages farmers to save in those VSLAs and receive loans to invest in CSA practices.

This study is based on baseline and endline data from small-scale farming households in project and control villages. It comprises a quasi-experimental impact evaluation with a difference-in-difference design to assess the impact pathway in five steps. The first step is comparing the households' access to agricultural, business and gender training in project villages with control villages. Second, we examine whether, from baseline to endline period, the adoption rate of CSA practices increases more in project villages than in control villages. Third, we test whether the increase is higher among households in project villages that participate in FFBS than those that do not participate. Fourth, we analyse whether the increase is more pronounced for the households in a project village that are members of VSLAs than those in project villages but not members of VSLAs. Fifth, we focus on the gender aspect of the impact pathway and analyse whether the adoption rate is increased further by the women's empowerment efforts in project villages.

The study is structured as follows. Chapter 2 describes the project region and the interventions (CSA, FFBS and VSLA). Chapter 3 exhibits the data used for the study. Chapter 4 presents the results of the pathway analysis. The paper ends with conclusions and policy implications (Chapter 5).

2 Intervention

2.1 Iringa region description

Our study is based on the Kukua ni Kujifunza[1] (KnK) project of CARE-Tanzania, implemented in villages at Iringa District Council, Tanzania. 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 cool/subhumid agroecological zone is characterized by low temperatures (15-20°C) and high rainfall levels (600-1000mm) when compared to the semi-arid plains of the lowlands (Karanja Ng'ang'a, et al., 2020). The Iringa district study site, one of the three districts (Mufindi, Kilolo and Iringa District Councils) in the Iringa region, is in the southern highlands of Tanzania. The colder rainy season from November to April is the primary growing season, while the dry season lasts from May to October (Karanja Ng'ang'a et al., 2020).

The Iringa region is one of the four major food-producing areas in Tanzania. The agricultural sector employs about 73% of economically active people and generates nearly 99% of the GDP of rural Iringa. The area enjoys a climate that favours the production of various crops, but production is vulnerable to climate variability. The region's climate has shown significant changes in the past 40 years. The average temperature has increased by more than 0.5°C, and annual average precipitation has become erratic (Osiemo & Kweka, 2019). However, the average income level is low, with annual GDP per capita amounting to 723 US$ (about 2 US$ per capita per day) (Iringa District Council, 2013). Those small-scale farmers are vulnerable to rainfall variability, lack knowledge on CSA practices and have limited access to finance. Female farmers are among the most disadvantaged in access to knowledge and finance (Osiemo and Kweka, 2019).

[1] Growing is Learning in Swahili.

2.2 Climate-smart agriculture (CSA) practices

The KnK project focused on CSA practices of soybean cultivation, mulching, crop rotation and intercropping, using inorganic fertilizer (composting) and rhizobium inoculation applications in 15 villages in Iringa District Council since 2018.[2] Introducing a legume such as soybean in the rotation increases soil fertility through nitrogen-fixing. Continuous crop rotation can also reduce pathogen pressure on the area. Also, intercropping is expected to reduce pathogen pressure compared with continuous monocropping. Furthermore, total production per hectare is expected to increase, even if each crop's yield's decreases because of crop competition. Also, the nitrogen-fixing characteristic of soybean contributes to the reduction of nitrogen emitted to the atmosphere, reducing GHG emissions from farming.

Soybean farming is new to the region's farmers and has not previously been found among the major agricultural value chains[3] (Osiemo & Kweka, 2019) but is expected to enhance the incomes of the farmers. Karanja Ng'ang'a et al. (2020) show that both crop rotation or intercropping of soybean with maize is profitable in the project villages. However, the returns from crop rotation are higher – by about 3000 US$) due to the lower labour input needed for crop rotation. Their study finds that the net present value of crop rotation of soybean with maize could earn farmers about 4000 US$ per hectare within two years.

As stipulated before, the intervention also comprised training farmers in CSA practices as part of the FFBSs programme and supporting access to drought-resilient soybean seed and inoculants from the input retailers. The project did not provide any subsidized input and was self-financed by participating farmers.

2.3 Farmer Field Business Schools (FFBS) approach

FFBS is a participatory approach that introduces new farming practices to small-scale farmers.[4] It helps them build skills necessary to increase production, increase access to

[2] The benefits of these practices were also confirmed by multiple stakeholders inlcuding stakeholders from the government participated in the project kick-off and close-out meetings in Tanzania.

[3] The climate risk profile studies by Osiemo & Kweka (2019) found that soybean was among the five economically most important agricultural value chains in the three districts of the Iringa region.

[4] Please see CARE (2013) for a summary of farmer field business schools' impact pathway.

markets, and sell at competitive prices to improve income. Women play a key role in the approach with the rationale that empowering women will facilitate agricultural productivity, profitability, and household resilience. It also transforms the status and recognition of women by providing the support they require to be successful farmers, business people, leaders, and agents of change. The approach also aims to improve nutrition and food security through increased agricultural production and income as well as training and education on food preparation and baskets (CARE, 2013).

Training on agriculture and business

Farmers in the project villages were offered three integrated FFBS training modules organized in 2018. First, CSA training was facilitated by establishing on-site demonstration plots in every village. CARE-Tanzania established the demonstration plots in collaboration with the local extension officers (Figure 1.1). The para-professionals – lead farmers that help extensions agents from the Ministry of Agriculture to identify plots with the CSA practices – selected by the local implementing partners managed the demonstration plots daily. Different varieties of soybean and their cultivation with manure-composting and rhizobium inoculation were tested in the demonstration plots. In addition to this, using demonstration plots, farmers are also taught how to use the mulching method, the benefits of crop rotation and intercropping in general, and crop rotation of soybean with other crops.

Image 2.1 A demonstration plot in a study village. Source Pamuk H. (WUR)

Second, business training was organized on collective marketing, business planning, the importance of loans, and how to use them. This training was given in a class format to the members of FFBSs.

Although all the trainings were given to the members of the FFBS, trainings were also open to other farmers who liked to join. Therefore a higher spill-over effect of the project is expected in the project villages.

Training on gender and nutrition

The project organized gender trainings where both men and female spouses involved in the project were expected to participate.[5] The objective of the training was twofold. First, it aimed to demonstrate how gender discrimination could leave female farmers behind, which negatively affects the overall welfare of the households and community. In the training process, couples role-played scenarios on land management and input access, nutritional decision making, workload sharing, income control, a traditional role model of men to demonstrate the existing situation and the ideal case. As a next step, they discussed in groups the daily activities and unequal workload sharing between men and women as a group, the differences between male and female behaviour, power relationships within the household, the contribution of women to household income and how men and women can share decision making equally.

The members of the FFBS also received training on nutrition. This training included general information on nutrition, food groups, and how a healthy and diverse diet looks like including the demonstration of a healthy plate. It was followed by cooking demonstrations, including demonstrations on how they can cook soybean for their family and the nutritional benefits of soybean consumption. Every month nutrition champions do the cooking demonstration whereby they cook nutritious porridge with soybean to all babies and their mothers who attended the events.

[5] Please see the full description of the gender tools in CARE Gender Tools in https://www.care.org/wp-content/uploads/2020/05/FFBS_4_Gender_Tools.pdf

2.4 VSLA approach

The implementation of the FFBS approach was combined with the VSLA approach through existing VSLAs in the study area. The VSLAs are self-funded and self-managed groups. They typically comprise 15-25 individual members in a community or village and usually meet weekly or biweekly. VSLA members self-select to save and to lend to each other employing a fund. The fund, including interests collected, are re-distributed to the members by the amount they save. Although the groups can include both men and women, usually most of the members are women. They operate independently, without additional technical support, after approximately one year. CARE Tanzania first introduced VSLAs in 2001 on Zanzibar, but they later spread to the Tanzanian mainland.

Village Community Banks (VICOBAs) were established in the study area in the past. These VICOBAs were like VSLAs because they were member-based, but their field practices differed (Maliti, 2017; Pamuk et al., 2020). For instance, while some VICOBAs had about 60 members, which is more than a typical VSLA (Pamuk et al., 2020), attendance at meetings was low, and not all VICOBAs kept the records of the financial transactions well.[6]

CARE transformed these existing VICOBAs into VSLAs. At the end of 2019, the project gave VICOBAs refreshing VSLA training streamlined by CARE. The training focused more on record-keeping because members had reported it as a challenge. To ease the record keeping, the project also provided members with a smartphone-based application.

2.5 Theory of change for FFBS+VSLA approach

Figure 2.2 summarizes the theory of change of the FFBS+VSLA approach. We identify three impact pathways in the approach. First is the training impact pathway, where the FFBSs are expected to improve the agricultural and business knowledge of the trained farmers. The second pathway is the VSLA channel, where FFBS members can leverage their VSLA

[6] In some VICOBAs loan enforcement mechanisms were not always based on group enforcement (e.g, asking the member who does not repay loan to leave, or the loan guarantor pays the loan) like in VSLAs. Instead, some VICOBAs sometimes socially funded the unrepaid loans from common pool of savings (Maliti, 2017; Pamuk et al., 2020).

memberships to solve their financial bottlenecks through, for example, saving or receiving loans for agricultural investment.

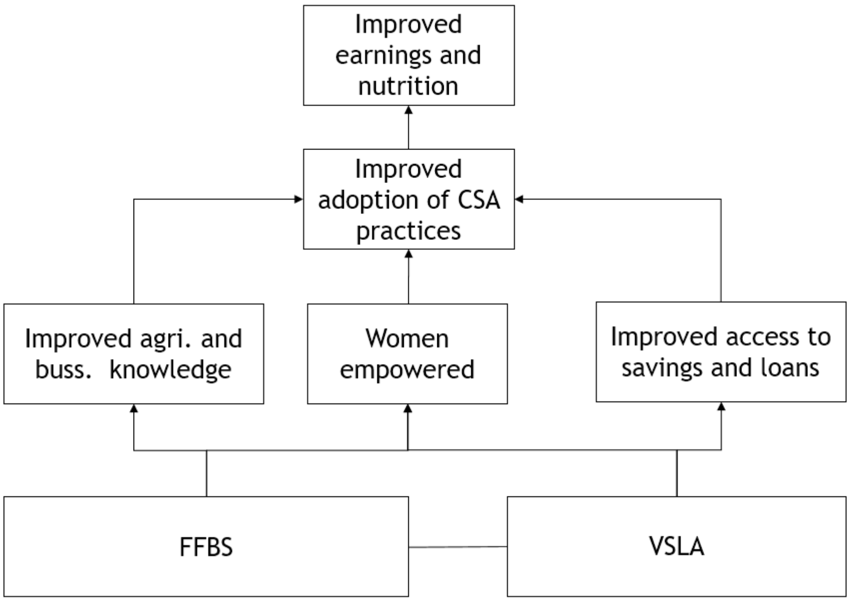

Figure 2.1: Theory of change for the FFBS+VSLA approach implemented in Iringa Tanzania

The third is the women's empowerment channel. The theory suggests that women who have increased control over household assets (resources), income, and agricultural production decisions and take leadership positions by involvement in community organizations are more likely to adopt the CSA practices introduced by the project. This study tests this theory of change for the adoption of CSA practices. It is also expected that improved CSA practices contribute to the income and nutrition level of the households. We also provide evidence on whether the approach contributes to the incomes and nutrition levels of the supported farmers through soybean sales and consumption. Particularly soybean has high nutritional value as a cheap source of protein with a higher protein content than other legumes; therefore, the consumption of it can have a high nutritional value for the rural farmers with low animal protein consumption (El-Agroudy et al.,2011; Foyer et al., 2018; Asodina et al., 2020).

3 Sampling design, indicators, and estimation procedure

3.1 Sampling design

To investigate the pathway effect of the FFBS+VSLA approach, we collected household-level data in two survey waves (i.e., baseline and endline) from 15 project villages and 18 control villages. Figure 3.1 shows the location of the project and control villages within the Iringa district and its agroecological zones. The control villages were selected with the help of the Ministry of Agriculture's local government based on their agroecological similarity with the project villages and a minimal level of intervention from external organizations.

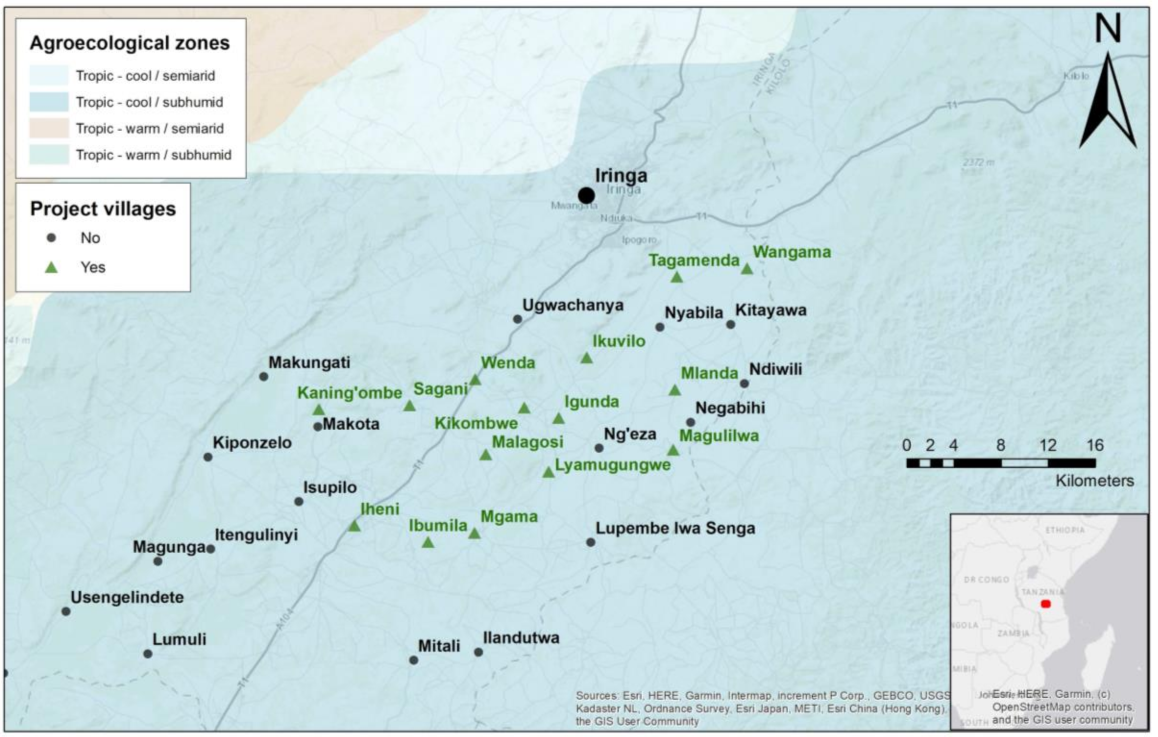

Image 3. 1: Distribution of project and control villages in the cool/subhumid agroecological zone of Iringa, Source Fuchs (2021)

An extensive baseline study was conducted in October-November 2018 using a farming household survey asking about the farming practices in the 2017-2018 farming season. Nine hundred sixty small-scale farming households (farmers hereon) were surveyed from the 33 project and control villages. In every village, farmers were randomly selected with the help of lists communicated by village leaders and extension officers. In the project villages, 40 farmers were randomly selected, of which 20 farmers had household members who were targeted by the project, and the project did not initially target the other 20. In the control villages, 20 farmers were randomly selected. In each farming household, the household head (either male or female) or a family member taking part in agronomic decision-making was surveyed. The same respondent answered all questions, including the ones concerning women's empowerment and the role of women in the households.

We note that when the baseline survey was completed, many farmers from project villages had already participated in training given by FFBS in the second half of 2018. However, as the agricultural season had already started, they did not have the opportunity to implement the practices. Therefore, we did expect that farmers in the project villages had already started to participate in the FFBS training at the project villages before the baseline survey (see Chapter 4 for detailed results).

The endline survey was completed in November 2020, comprising almost identical questions that targeted the same household members as those included in the baseline survey, asking about the 2019-2020 farming season. Among 960 households that participated in the baseline, 859 participated in the endline survey. We could not revisit all as some had relocated (i.e., 27 control group farmers, 30 permanent FFBS farmers, and 44 non-permanent FFBS farmers at the project villages).

This study reports the results for 603 farmers (270 FFBS members from the project villages and 333 control village farmers) who participated in both baseline and endline surveys. We use farmers that participated in both surveys in our analysis to eliminate the effect of farm and farmer characteristics from baseline to endline survey. From project villages, we only use data from farmers that are initially targeted by the project. This is for economizing on space: only reporting the results collected from control villages and farmers initially targeted by the project simplifies the presented tables. We note that the results (not included in this paper but available upon request) for farmers from project villages with household members who were and were not initially targeted by the project were similar. This is because the project upscaled its activities, and many farmers from the project villages and the initial FFBS members benefited from the project.

Table 3.1: Baseline characteristics of control and project village farmers

	Control village (1)	Project village (2)	(1)-(2)
Female household head (No=0, Yes=1)	0.21	0.30	-0.09**
Age of the household head (year)	48.01	47.99	0.02
Household head with primary education or no education (No=0, Yes=1)	0.84	0.87	-0.03
Household expenditure on consumption goods over the past 30 days (TZS)	22,066	23,477	-1411
Farm size (acre)	3.04	2.70	0.34**
Distance from house to the main road (walking minutes)	7.23	12.19	-4.96***
Cow breeding (No=0, Yes=1)	0.24	0.16	0.07**
Sheep breeding (No=0, Yes=1)	0.02	0.03	-0.01
Goat breeding (No=0, Yes=1)	0.08	0.09	0.00
Chicken breeding (No=0, Yes=1)	0.84	0.85	-0.01
Credit from banks over the past season (No=0, Yes=1)	0.04	0.02	0.02
Credit from microfinance inst. over the past season (No=0, Yes=1)	0.08	0.13	-0.05*

*, **, ***, indicates p-value<0.10, p-value<0.05, and p-value<0.01, respectively. P-values are estimated using standard errors clustered at village level.

We present the baseline characteristics of those 603 farmers from control and project villages in Table 3.1. On average, our farmers are small-scale with about 3 acres of farmland and spend about 23000 Tanzanian Shillings (TZS), equivalent to about 10 US$ on consumption goods over the past 30 days. Chicken ownership is highest among livestock ownership. Few farmers can access credit from banks or microfinance institutions. Project and control village farmers statistically differ in terms of the gender of the household head, farm size, distance to the main road, and access to finance from microcredit institutions. We control for those characteristics in our detailed regression analysis through fixed-effects regressions, and our results are robust to those controls.

3.2 Outcome Indicators

Both baseline and endline household surveys included, among others, outcome indicators on the adoption of CSA practices, participation in FFBS training and VSLA, as well as women's empowerment.

3.2.1 CSA practices

From the thorough list of potential CSA practices, we focus on the practices that are supported by FFBS, namely crop rotation, intercropping, manure composting, mulching, and soybean cultivation. Farmers can practice crop rotation, intercropping, inorganic fertilizer, and mulching for different crops. Therefore we use binary adoption indicators that equal 1 when the practice is used (0 otherwise). For the adoption of soybean, we use more detailed practices. Specifically, we use indicators of binary adoption and the number of acres and kg soybean produced. To examine the contribution of soybean production to the consumption and income of the farmers, we use binary and kg based soybean consumption and sales indicators as well as the amount of Tanzanian Shillings (TZS) earnings from soybean sales and price per kg received for soybean sales. We note that soybean production, consumption and sales measured in acres, kg, earnings are zero for many farmers who do not produce, consume, or sell soybean. Therefore the distribution of those variables is skewed. For those series, t-test statistics that we will use might not produce correct results as they are not normally distributed. We also report results from inverse hyperbolic sine (ihs) transformation of those skewed variables as proposed by Bellemare and Wichman (2020) and use those transformed series to test our hypothesis.

3.2.2 FFBS training and access to VSLA services

Participating in FFBS training is measured binary as well as the total number of times the farmers participated, in addition to farmers' participation in training sessions on 17 topics (binary), including farming, business practices, and gender training. VSLA indicators address membership over the past year (binary), use of credit and savings (both binary as well as the amount in TZS)[7] and purpose of credit uptake for farming, non-farming, and consumption (binary). Again we also report the ihs transformation of the VSLA indicators in TZS to find correct test results of equality.

3.2.3 Women’s empowerment

We use five empowerment indicators to study the influence of women’s roles on adopting CSA practices.[8] Four of those indicators are the proxies of four out of five domains of the Women's Empowerment in Agriculture Index (WEAI), designed to measure relative control and empowerment between spouses ideally by surveying both spouses separately. Those four indicators measure how much control female adults have within their households over production decisions, resources, income, and leadership in the community. Each indicator

[7] 1000 Tanzanian Shillings (TSh.) equals approximately 0.43 US$.

[8] Please also see Fuchs (2021) for a detailed discussion and use of our women’s empowerment indicators.

scores between 0 and 1 (see Appendix A for a more detailed description of the proxy indicators). Larger indicator values show greater empowerment of women. We also constructed the fifth indicator, averaging the scores for four domains. Each one of the four indicators contributes to 25% of the fifth empowerment score.

Some important notes on the construction of the indicators are as follows. First, the same respondent, regardless of whether that respondent was male or female, who answered other survey questions also answered the questions on women’s empowerment. Second, households with single or widowed female household heads are excluded in this analysis concerning women’s empowerment. This is because WEAI indicators measure women’s empowerment relative to male household members. Therefore, in single women's households, the indicators are not meaningful. Third, we could interview only one member of each household but not both male and female adults as the original WEAI suggests due to the time limitations in the data collection.[9] Fourth, compared to the original WEAI, we do not have the fifth indicator, comparing the time spent on household tasks (e.g. cooking, cleaning and childcare) by female and male adults. Our indicators rather measure the ability to decide on farming, credit, and capacity to speak publicly.

3.3 Estimation strategy

3.3.1 The effect of the FFBS+VSLA approach

The effectiveness of the FFBS intervention for the key CSA adoption practices was assessed through a quasi-experimental impact evaluation using difference-in-difference estimation. We first estimate the participation rate in the training of FFBS, access to VSLAs, women’s empowerment in agriculture in baseline and endline periods separately for project and control villages and compare them. Then we compare the changes in those two years between the farmers from project villages and control villages. To compare the changes, we estimate the following model:

[9] This study could not construct a gender parity index of the WEAI approach that measures the empowerment gap between the primary adult male and female household members, contributing to 10% of the original score, because we did not survey both female and male adult in the households.

$$Y_{ivt} = \beta_0 + \beta_1 Endline_t + \beta_2 Project_v + \beta_3 Endline_t \times Project_v + \epsilon_{ivt} \quad (1)$$

where i denotes the farmer, v represents a village, and t denotes time. $Endline_t$ equals 1 when the model use endline survey data (0 otherwise), and $Project_v$ equals 1 when the farmer is from a village where the FFBS+VSLA approach is introduced (0 otherwise). ϵ_{ivt} is the random error term. Y_{ivt} is the outcome indicator. We use participation in the training of FFBS, access to VSLA, women's empowerment in agriculture, and adoption of CSA practices as outcome variables. β_1 estimates the average difference in the outcome indicators between endline and baseline period. β_2 estimates the average difference between FFBS and control village in the baseline period. Our key variable of interest is β_3 which estimates the intention to treat estimates of the project - average effect of the project on the households that the project initially planned to intervene in through the FFBS+VSLA approach.

3.3.2 Investigating the impact pathway

Next, we investigate the training, microfinance, and women's empowerment impacts pathways of the FFBS+VSLA approach, respectively.

FFBS training impact pathway

We first estimate whether the adoption rate of practices is higher among the farmers that are from project villages and participated in FFBS training when compared to farmers that did not participate in the training but in project villages. We estimate the following model:

$$Y_{ivt} = \alpha_0 + \alpha_1 Endline_t + \alpha_2 Project_v + \alpha_3 FFBS_{it} + \alpha_4 Endline_t \times Project_v + \alpha_4 Endline_t \times FFBS_{it} + \alpha_5 Endline_t \times Project_v \times FFBS_{it} + \epsilon_{ivt} \quad (2)$$

where $FFBS_{ti}$ equals 1 if a member of a farming household participated in a training of FFBS (0 otherwise). We test $\alpha_5 \neq 0$ to examine the change in the effect of the FFBS+VSLA approach on CSA practices with participation in the training.

VSLA impact pathway

Second, we explore whether adopting practices increases when farmers from project villages are also VSLA members. We estimate the mean level of CSA adoption indicators in baseline and endline periods at FFBS and control villages, separately for VSLA members and non-member farmers. Then we compare whether the effect of the FFBS+VSLA approach is different (higher) for VSLA members than non-member farmers. For this purpose, we estimate the following model only for those who had adopted CSA practices:

$$Y_{ivt} = \alpha_0 + \alpha_1 Endline_t + \alpha_2 Project_v + \alpha_3 VSLA_{it} + \alpha_4 Endline_t \times Project_v + \alpha_4 Endline_t \times VSLA_{it} + \alpha_5 Endline_t \times Project_v \times VSLA_{it} + \epsilon_{ivt} \quad (3)$$

where $VSLA_i$ equals 1 if the farmer is a member of VSLA (0 otherwise). We test $\alpha_5 \neq 0$ to examine the change in the effect of the FFBS+VSLA approach on CSA practices with the membership of VSLA.

Women's empowerment impact pathway

Finally, we analyze whether higher levels of women's empowerment amplify the effect of the FFBS+VSLA approach on the adoption of CSA practices, using the following model:

$$Y_{ivt} = \alpha_0 + \alpha_1 Endline_t + \alpha_2 FFBS_v + \alpha_3 Womenemp_{it} + \alpha_4 Endline_t \times FFBS_v + \alpha_4 Endline_t \times Womenemp_{it} + \alpha_5 Endline_t \times FFBS_v \times Womenemp_{it} + \epsilon_{ivt} \quad (4)$$

where $Womenemp_{it}$ is the average score of the four dimensions of WEAI. Again we test $\alpha_5 \neq 0$ to examine the change in the effect of the FFBS+VSLA approach on CSA practices with women's empowerment in agriculture.

We use standard errors clustered at the village level in all our analyses and estimate all models using OLS estimation. Our results are also robust to controlling for farmer fixed effects.

4 Results

4.1 The effect of FFBS+VSLA approach on training, savings/loans, women's empowerment

Access to FFBS and VSLA services by farmers from project and control villages in the endline and baseline survey periods are summarized in Tables 4.1 and 4.2. Specifically, Table 4.1 reports the fraction of farmers who participated in the FFBS and the number of training, while Table 4.2 reports the membership in VSLAs as well as loans received and savings deposited. Columns 3 and 7 in both tables compare the access in project and control villages in endline and baseline period, respectively. Estimates of β_3 The model (1) is shown in column 11, reporting the change in access to services from baseline and endline (i.e., diff in diff). The statistical difference is tested between the change endline and baseline (columns 4 and 8 projects and control respectively) and access to services between farmers from project and control villages over time (column 12).

Farmers in the project villages are better trained in CSA and business practices than those in control villages (Table 4.1). In the 2019-2020 season, about 57% of project farmers participated in FFBS activities, while 17% of farmers in control villages participated in similar activities. The participation rate of farmers from project villages to the various training ranges from 38% (business planning) to 54% (fertilizer use) in the endline survey period. It is significantly higher when compared to control villages ($p<0.01$). We note that these farmers participated and completed their training before the baseline survey was implemented, as explained in Chapter 2, and farmers received training before our baseline survey. Therefore, we do not detect any improvement in the participation in FFBS and its training modules from baseline to endline period.

Access to finance from VSLAs has improved throughout the project (Table 4.2). In the baseline 2017-2018, we do not observe a statistically significant difference between project and control villages regarding membership in and access to finance from VSLAs. However, in the endline (2019-2020), farmers from the project villages are more likely to be members of VSLA villages (50%) than those from control group villages (32%). Those farmers from project villages are more likely to receive loans (14%-points, $p<0.10$) and more likely to save in the VSLAs than control group farmers in 2019-2020 (20%- points, $p<0.05$). Particularly access to loans and savings from VSLAs have improved during the project compared to control group villages (column 11). The amount in loans granted and saving deposits per farmer more than doubled in project VSLAs compared to farmers in control VSLAs. These are equivalent to over 20,000 TZS (8.6 US$) additional loans and 30,000 TZS (12.9 US$) additional savings for project village farmers than control village farmers. Our results for the ihs transformation of the loans show that this difference is statistically significant ($p<0.05$). The result also indicates that the fraction of farmers using the loans for non-farm businesses and utilizing the savings for farming and non-farming businesses increased more in the project than control villages, as detected again by the ihs transformation of the saving variables ($p<0.05$). These findings imply that interventions (e.g., improvements in VSLAs and encouragement of savings for agriculture) have facilitated savings for agricultural activities.

We also test whether the project farmers' business practices have improved compared to control farmers' business practices. Table 4.3 compares the fraction of farmers who purchase inputs and sell outputs collectively, keep farming records and have a business plan in endline and baseline periods. In terms of collective purchase and record-keeping, the improvement in the project villages is exceeding the improvements in control villages, indicating the positive contribution of the project to the collective purchase and record-keeping practices of farmers (column 11, ranging from 6% to 13%- points, $p<0.01$).

Finally, we examine whether the FFBS+VSLA approach contributes to women's empowerment. Table 4.4 shows that the approach improved the leadership role of women ($p<0.01$) measured by their involvement of socio-economic groups in the village, corresponding to a 0.16 (55% when compared to baseline control village average) increase in the leadership score. However, we do not detect a statistically significant effect on women's control over income, resources, and production. The improvement in women's leadership is reflected in the overall women's empowerment index, showing a positive change in women's empowerment which is higher in project villages than control group villages.

Table 4.1: Participation in training at project and control villages, endline and baseline surveys

		Endline				Baseline				Endline vs Baseline			
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Variables		Project	Control	Diff.	Sig.	Project	Control	Diff.	Sig.	Project	Control	Diff. in Diff.	Sig.
		Mean	Mean	(1)-(2)		Mean	Mean	(5)-(6)		(1)-(5)	(2)-(6)	(9)-(10)	
Panel A: Access to FFBS													
Participated in FFBS training	No=0, Yes=1	0.57	0.17	0.40	***	0.47	0.13	0.35	***	0.09	0.04	0.05	
Panel B: Participation in FFBS training													
Demonstration plots	No=0, Yes=1	0.51	0.15	0.36	***	0.44	0.10	0.35	***	0.07	0.06	0.01	
Fertilizer use	No=0, Yes=1	0.54	0.16	0.38	***	0.46	0.12	0.34	***	0.09	0.05	0.04	
Compost manure	No=0, Yes=1	0.53	0.13	0.39	***	0.46	0.11	0.35	***	0.07	0.02	0.05	
Pest and diseases	No=0, Yes=1	0.46	0.16	0.31	***	0.45	0.11	0.33	***	0.02	0.04	-0.03	
Spraying	No=0, Yes=1	0.50	0.16	0.34	***	0.44	0.11	0.33	***	0.06	0.05	0.01	
Post-harvest handling	No=0, Yes=1	0.50	0.16	0.34	***	0.43	0.11	0.33	***	0.07	0.05	0.02	
Processing & marketing strategies	No=0, Yes=1	0.43	0.12	0.32	***	0.40	0.08	0.32	***	0.03	0.04	-0.01	
Crop rotation	No=0, Yes=1	0.46	0.13	0.33	***	0.43	0.11	0.33	***	0.03	0.03	0.00	
Intercropping of soya with maize	No=0, Yes=1	0.40	0.09	0.31	***	0.39	0.10	0.29	***	0.01	-0.01	0.02	
Manuring	No=0, Yes=1	0.51	0.14	0.37	***	0.45	0.12	0.34	***	0.06	0.02	0.03	
Collective marketing	No=0, Yes=1	0.43	0.12	0.32	***	0.40	0.07	0.32	***	0.04	0.05	-0.01	
Business planning	No=0, Yes=1	0.35	0.11	0.25	***	0.38	0.07	0.31	***	-0.03	0.04	-0.06	
Record keeping	No=0, Yes=1	0.38	0.11	0.26	***	0.39	0.09	0.30	***	-0.01	0.03	-0.03	
Loans and how to use them	No=0, Yes=1	0.41	0.11	0.30	***	0.40	0.08	0.32	***	0.01	0.03	-0.02	
Gender issues	No=0, Yes=1	0.46	0.14	0.33	***	0.43	0.09	0.34	***	0.03	0.05	-0.02	

Notes: Estimates for 270 farmers in 15 project villages and 333 farmers from 18 control villages. We only use farmers that participate in both surveys. *, **, ***, indicates p-value<0.10, p-value<0.05, and p-value<0.01, respectively. P-values are estimated using standard errors clustered at the village level. Estimates of β_3 from the model (1) are shown in column 11.

Table 4.2: Participation in VSLAs in project and control villages, endline and baseline surveys

Variables		Endline (1) Project Mean	(2) Control Mean	(3) Diff. (1)-(2)	(4) Sig.	Baseline (5) Project Mean	(6) Control Mean	(7) Diff. (5)-(6)	(8) Sig.	Endline vs Baseline (9) Project (1)-(5)	(10) Control (2)-(6)	(11) Diff. in Diff. (9)-(10)	(12) Sig.
Have you ever heard of VSLA?	No=0, Yes=1	0.93	0.94	-0.01		0.93	0.93	-0.01		0.01	0.01	0.00	
Have you or someone from your family ever been a member of VSLA?	No=0, Yes=1	0.51	0.33	0.18	**	0.33	0.21	0.12		0.19	0.12	0.07	
Have you (or someone from your family) been still a member of the VSLA over the past year?	No=0, Yes=1	0.50	0.32	0.18	**	0.31	0.20	0.11		0.19	0.12	0.07	
Over the last year, have you received a loan from VSLA?	No=0, Yes=1	0.39	0.24	0.14	*	0.22	0.17	0.05		0.17	0.08	0.09	
How much?	TZS	81,674	53,979	27,695		37,407	32,072	5,335		44,267	21,907	22,360	
	TZS, ihs	4.88	2.95	1.93	*	2.73	1.98	0.75		2.15	0.97	1.18	**
For which purpose have you used the loan? Farming	No=0, Yes=1	0.19	0.16	0.03		0.14	0.11	0.04		0.05	0.06	0.00	
For which purpose have you used the loan? Non-farming	No=0, Yes=1	0.20	0.09	0.10	**	0.06	0.05	0.01		0.13	0.04	0.09	
For which purpose have you used the loan? Consumption	No=0, Yes=1	0.00	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00	**
Over the last year, have you saved money through VSLA?	No=0, Yes=1	0.45	0.25	0.20	***	0.26	0.19	0.07		0.20	0.07	0.13	
How much?	TZS	101,259	60,865	40,394	*	43,544	33,982	9,562		57,715	26,883	30,832	
	TZS, ihs	5.11	2.74	2.37	***	2.39	1.52	0.88		2.72	1.22	1.5	**
What did you save the money for? Farming	(0/1)	0.30	0.19	0.12	**	0.20	0.14	0.05		0.11	0.05	0.06	**
What did you save the money for? Non-farming	No=0, Yes=1	0.28	0.15	0.13	***	0.14	0.09	0.04		0.14	0.05	0.09	-
What did you save the money for? Consumption	No=0, Yes=1	0.01	0.00	0.00		0.01	0.02	0.00		0.00	-0.01	0.01	**

Notes: Estimates for 270 farmers in 15 project villages and 333 households from 18 control villages. We only use households that participate in both surveys. *, **, ***, indicates p-value<0.10, p-value<0.05, and p-value<0.01, respectively. P-values are estimated using standard errors clustered at the village level. All TZS values are winsorized at 5% level. Ihs indicates the inverse hyperbolic sine transformation. Estimates of β_3 from the model (1) are shown in column 11.

Table 4.3: Business practices in project and control villages, endline and baseline surveys

		Endline				Baseline				Endline vs Baseline			
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Variables		Project	Control	Diff	Sig.	Project	Control	Diff.	Sig.	Project	Control	Diff. in Diff.	Sig.
		Mean	Mean	(1)-(2)		Mean	Mean	(5)-(6)		(1)-(5)	(2)-(6)	(9)-(10)	
Did you sell collectively your agricultural goods and services in the past 12 months?	No=0, Yes=1	0.11	0.04	0.07	**	0.05	0.03	0.02		0.06	0.02	0.05	
Did you buy collectively your agricultural goods and services in the past 12 months?	No=0, Yes=1	0.11	0.04	0.07	**	0.01	0.00	0.00		0.10	0.04	0.06	**
Have you or someone from your family ever kept the records of sales, input purchases, and production in a booklet or notebook ever?	No=0, Yes=1	0.29	0.22	0.06	*	0.09	0.15	-0.05	**	0.19	0.08	0.12	***
Did you keep the records for the last season?	No=0, Yes=1	0.27	0.20	0.07	**	0.07	0.14	-0.06	**	0.20	0.06	0.13	***
Have your household had a business plan ever?	No=0, Yes=1	0.17	0.15	0.02		0.22	0.25	-0.03		-0.05	-0.10	0.05	
Did you have a business plan for the last season?	(0/1)	0.12	0.12	0.00		0.16	0.22	-0.06		-0.04	-0.10	0.06	

Notes: Estimates for 270 farmers in 15 project villages and 333 farmers from 18 control villages. We only use farmers that participate in both surveys. *, **, ***, indicates p-value<0.10, p-value<0.05, and p-value<0.01, respectively. P-values are estimated using standard errors clustered at the village level. Estimates of β_3 from the model (1) are shown in column 11.

Table 4.4: Gender empowerment in project and control villages, endline and baseline surveys.

		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
		Endline				Baseline				Endline vs Baseline			
	Unit	Project Mean	Control Mean	Diff. (1) - (2)	Sig.	Project Mean	Control Mean	Diff. (5) - (6)	Sig.	Project (1)-(5)	Control (2)-(6)	Diff. in diff. (9)-(10)	Sig.
Control over production	(0-1)	0.78	0.73	0.05		0.84	0.83	0.01		-0.06	-0.1	0.04	
Control over resources	(0-1)	0.83	0.79	0.04		0.88	0.83	0.05		-0.05	-0.04	-0.01	
Control over income	(0-1)	0.77	0.73	0.04		0.815	0.819	-0.004		-0.05	-0.09	0.04	
Leadership	(0-1)	0.6	0.29	0.31	***	0.39	0.24	0.15	***	0.21	0.05	0.16	***
Empowerment index	(0-1)	0.74	0.62	0.12	***	0.71	0.66	0.05	**	0.03	-0.04	0.07	**

Notes: Estimates for 270 farmers in 15 project villages and 333 farmers from 18 control villages. We only use farmers that participate in both surveys. *, **, ***, indicates p-value<0.10, p-value<0.05, and p-value<0.01, respectively. P-values are estimated using standard errors clustered at the village level. Estimates of β_3 from the model (1) are shown in column 11.

4.2 The effect of the FFBS+VSLA approach on the adoption of CSA practices

Next, we focus on the key results of our study on adopting specific CSA practices. Panel A in Table 4.5 is used to estimate adoption results for agricultural practices, and Panel B is used to estimate adoption results for soybean production and consumption. While Panel A focuses on the agricultural practices used, Panel B shows the specific results concerning soybean.

There was no significant difference between project and control farmers regarding the adoption of agricultural practices in the baseline period, except intercropping (column 8). However, from baseline to endline, the fraction of farmers adopting mulching, manure composting, crop rotation, and rhizobium inoculation in project villages is significantly higher when compared to the control villages (column 9). In project villages, the adoption rate of mulching, manure composting, crop rotation and inoculation increased between 7% to 14% points. All these increases are statistically higher than the observed increments in control villages, revealing that FFBSs stimulated CSA adoption. We do not detect the effect of FFBS+VSLA on intercropping. This might be because farmers find the adoption of intercropping not economically viable. For instance, Ng'ang'a et al. (2020) show that intercropping of soybean with maize is less profitable than crop rotation due to the additional labour costs. Also, in our conducted interviews, the lead farmers from the project villages pointed out that they find it inefficient to implement intercropping in small plots and prefer crop rotation.

We also investigate the effect of the FFBS+VSLA approach on the key soybean adoption in more detail. When the project started, the fraction of farmers producing soybean was approximately 3% in both project and control villages. The average production ranged from 1 kg to 4 kg per farm (columns 5 and 6). None of the consumption and sales indicators was statistically different between project and control villages in the baseline. After two years of encouraging soybean adoption, the fraction of soybean adoption increased to 36% in the project villages (column 1) while it remained stable in the control villages (difference in differences effect amounted to 35% at $p<0.01$, column 11).

On average, a project farmer harvested approximately 23 kg of soybean using 0.12 acres of farmland in the 2019-2020 farming season (column 1). When we exclude the farmers not producing soybean, this amounts to 64 kg per project farmer (0.33 acre of land). In the same season, 32% of project farmers (about 89% of soybean producers) consumed on average 7 kg of soybean (equivalent to about 22 kg of soybean consumption for the farmers who consumed the soybean they had produced). About 12% of project farmers (one-third of the soybean producers) sold on average 6 kg soybeans. In 2019-2020, project farmers report that the average farmgate soybean price was 1,397 TZS (0.60 US$) per kg. As a result, sales of the project farmers increased on average by 4,989 TZS (2.15 US$), and more specifically, soybean selling project farmers by 41,575 TZS (17.94 US$).

These results on CSA practices and, more specific on soybean production, show that the FFBS+VSLA approach can improve the adoption of CSA practices, including soybean production and consumption, which contributes to the nutrition level of farmers and improves their income. Using the findings from Ng'ang'a et al. (2020) and correcting for the 0.60 US$ per kg price – which was found to be 0.75 US$ per kg in their study), we roughly estimate the annual income contribution of soybean production. Our estimates show that the net present value of producing soybean is about 419 US$ in 15 years period when the farming area for soybean and prices do not change.[10] Soybean consumption is also important for the nutrition level of the farmers. In the baseline survey, in a seven-day period, about 91% of the farmers in project villages ate dry beans at least once. About 45% of them ate cow meat, 33% could eat dry fish at least once in the same seven day period. This shows that the farmers rely on bean-sourced protein instead of animal-sourced protein. Soybean, which has a higher protein content than other beans, help farmers to close that protein intake gap, providing a cheap and protein rich legume alternative.

[10] To estimate the value of soybean adoption we use the estimate from N'gan'ga et al. (2020) for the net present value cultivation crop-rotation of soybean with early maturing soybeans. This equals to 4028 US$ per hectare net present value over a 15-year period. In that study authors use a soybean price of 0.75 US$ per kg but in our study the price is 0.60 US$ per kg. Moreover, a soybean-producing farmer use 0.13 hectare of land for soybean. Then we estimate 15 years net present value using formula: 4028 US$*(0.60/0.75)*0.13=419 US$

This consumption and income effect of the FFBS+VSLA approach could be higher if farmers would allocate more area for soybean farming or the rest of the farmers. The average farm size in our sample is about 2.85 acres, while soybean producing farmers only use 0.33 acres of those farms (about 10% of total farm size). This gives an important opportunity to upscale the adoption of soybean. Moreover, about 64% of farmers who participated in the project villages did not adopt soybean, so there is much room for improvement in upscaling. To understand the factors preventing the adoption of soybean production among the 64% of non-adopters, we checked the barriers reported by the farmers who participated in the project villages in our endline survey. Three major reasons for not adopting were identified. They include the cost of production, unsuitable weather[11] or field conditions, and lack of access to seeds due to limited supply. Respectively about 30%, 23%, and 21% (74% in total) of non-adopters report those as the reasons for not cultivating soybean.

[11] Our informal conversations in the field with farmers show that the rains were early in the 2019-2020 cropping season and that might have influenced their decision.

Table 4.5: Use of agricultural technologies, soybean production and consumption in project and control villages, endline and baseline surveys

	Unit	(1) Endline Project Mean	(2) Control Mean	(3) Diff. (1) - (2)	(4) Sig.	(5) Baseline Project Mean	(6) Control Mean	(7) Diff. (5) - (6)	(8) Sig.	(9) Endline vs Baseline Project (1)-(5)	(10) Control (2)-(6)	(11) Diff. in diff. (9)-(10)	(12) Sig.
Panel A: Have you used the following agricultural practices over the past year?													
Mulching	No=0, Yes=1	0.31	0.20	0.11	***	0.06	0.06	-0.01		0.25	0.13	0.12	***
Manure composting	No=0, Yes=1	0.74	0.64	0.10	***	0.53	0.56	-0.03		0.21	0.08	0.13	**
Crop rotation	No=0, Yes=1	0.37	0.27	0.10	***	0.11	0.14	-0.04		0.27	0.13	0.14	***
Intercropping	No=0, Yes=1	0.58	0.56	0.02	-	0.64	0.56	0.08		-0.06	0.00	-0.06	
Rhizobium inoculation	No=0, Yes=1	0.15	0.08	0.07	***	0.00	0.00	0.00		0.15	0.08	0.07	***
Panel B: Soybean adoption, production, consumption, and sales													
Did you produce soya over the last season?	No=0, Yes=1	0.36	0.02	0.34	***	0.03	0.03	0.00		0.33	-0.01	0.35	***
How many acres?	Acre	0.12	0.01	0.11	***	0.01	0.02	-0.01		0.11	-0.01	0.12	***
How much of this product was harvested during the last season?	Kg	23.26	2.18	21.08	***	1.17	4.46	-3.39		22.09	-2.28	24.37	***
	Kg (ihs)	1.49	0.10	1.39	***	0.06	0.15	-0.09		1.43	-0.05	1.48	***
Does the household consume some of this harvest over the past season?	No=0, Yes=1	0.32	0.02	0.30	***	0.02	0.01	0.01		0.29	0.01	0.29	***
How much of the harvest was consumed?	Kg	7.15	0.23	6.92	***	0.15	0.51	-0.36		7.00	-0.28	7.28	***
	Kg(ihs)	0.97	0.04	0.93	***	0.03	0.04	-0.02		0.94	0.00	0.94	***
Does the household sell some of this harvest?	No=0, Yes=1	0.12	0.01	0.11	***	0.01	0.03	-0.02		0.11	-0.02	0.13	
Of the quantity harvested, how much did the household sell?	Kg	6.10	0.43	5.68	***	1.70	4.38	-2.68		4.40	-3.95	8.35	**
	Kg(ihs)	0.48	0.04	0.44	***	0.05	0.15	-0.1		0.43	-0.11	0.54	***
What was the average selling price per unit?	TZS	167.67	22.36	145.32	***	15.52	19.97	-4.45		152.15	2.39	149.76	***
Did you sell collectively?	No=0, Yes=1	0.21	0.02	0.19	***	0.01	0.05	-0.04		0.20	-0.03	0.23	***
Earnings from the sales of soybean	TZS	8360	2733	5627	*	3611	2973	638		4749	-240	4989	
	TZS (ihs)	1.28	0.12	1.16	***	0.10	0.33	-0.23		1.18	-0.21	1.39	***

Notes: Estimates for 270 farmers in 15 project villages and 333 farmers from 18 control villages. We only use farmers that participate in both surveys. *, **, ***, indicates p-value<0.10, p-value<0.05, and p-value<0.01, respectively. P-values are estimated using standard errors clustered at the village level. Estimates of β_3 from the model (1) are shown in column 11.

4.3 Impact pathway of the FFBS+VSLA approach

4.3.1 FFBS impact pathway

We examine whether the adoption rates of agricultural practices increase with the participation in FFBS training (Table 4.6). We assume a farmer (farming household) participated in the FFBS activities if any household member participated in FFBS activities. Estimates of α_5 from the model (2) are shown in row 27 of Table 4.6. It compares the change in the adoption from baseline and endline for project and control villages when they participated or did not participate in FFBS activities. For those farmers who participated in FFBSs, when we compare the project and control farmers, the estimates indicate that the participation in FFBSs has significantly increased the adoption rates of mulching from baseline to endline (row 11, $p<0.05$). For other practices, we do not detect such an increase in the adoption rates of agricultural practices. The adoption rate of intercropping decreased significantly among the farmers who did not participate in FFBS activities when comparing project and control villages (row 23, $p<0.05$), showing disadoption of intercropping practice. This might be because farmers that did not participate in FFBS activities did not sufficiently learn about the benefits of intercropping and therefore gave up using the technology. More research should be done on this issue.

Next, we test whether farmers that participated in FFBS adopted soybean more intensively than farmers that did not participate (Table 4.7). In project villages, both farmer groups that participated and did not participate in FFBS activities increased the adoption rate of soybean and soybean production, consumption, and sales when comparing project and control village farmers (rows 11 and 23 of Table 4.7). This increase was much more pronounced among the farmers who participated in FFBS. For instance, among farmers that participated in FFBS, the adoption rate of soybean increased by 48 percentage points more in project villages than control villages (row 11 and column 1). Among farmers that did not participate, the adoption rate of soybean increased by 15 percentage points more in project villages (row 23 and column 1). This implies that participation in FFBS activities increased the adoption rate of soybean by about 35 percentage points more in project villages when compared to control villages (row 27, $p<0.01$). This effect was also reflected in other soybean production, consumption, and sales indicators. Thanks to FFBS activities, the area reserved for soybean production increased by 0.15 acres, resulting in about 35 kg more soybean production and

12 kg more soybean consumption. These results imply that participation in FFBS played a key role in the upscaling of soybean production through the FFBS+VSLA approach, confirming the FFBS impact pathways of the approach. The approach also had spill over effects on soybean adoption among the farmers who did not participate in FFBS activities at the project villages, shown by increased soybean adoption.

Table 4.6: Agricultural practices in project and control villages by FFBS participation

					(1) Mulching Yes=1, No=0	(2) Manure composting Yes=1, No=0	(3) Crop rotation Yes=1, No=0	(4) Intercropping Yes=1, No=0	(5) Inoculation Yes=1, No=0
(1)	FFBS participant	Endline	Project	Mean	0.33	0.80	0.44	0.67	0.22
(2)			Control	Mean	0.20	0.75	0.35	0.60	0.15
(3)			Diff.	(1)-(2)	0.13	0.05	0.09	0.07	0.07
(4)			Sig.		**				
(5)		Baseline	Project	Mean	0.07	0.56	0.13	0.61	0.00
(6)			Control	Mean	0.12	0.64	0.12	0.69	0.00
(7)			Diff.	(5)-(6)	-0.05	-0.08	0.01	-0.08	0.00
(8)			Sig.						
(9)		Endline vs Baseline	Project	Mean	0.26	0.24	0.31	0.06	0.22
(10)			Control	Mean	0.08	0.11	0.23	-0.09	0.15
(11)			Diff.	(3)-(7)	0.18	0.13	0.09	0.15	0.07
(12)			Sig.		**				
(13)	Non-FFBS participant	Endline	Project	Mean	0.27	0.67	0.28	0.46	0.06
(14)			Control	Mean	0.19	0.62	0.25	0.55	0.07
(15)			Diff.	(13)-(14)	0.08	0.05	0.03	-0.09	-0.01
(16)			Sig.		*				
(17)		Baseline	Project	Mean	0.04	0.51	0.09	0.66	0.00
(18)			Control	Mean	0.05	0.55	0.15	0.54	0.00
(19)			Diff.	(17)-(18)	-0.01	-0.04	-0.06	0.12	0.00
(20)			Sig.					***	
(21)		Endline vs. Baseline	Project	Mean	0.23	0.16	0.19	-0.2	0.06
(22)			Control	Mean	0.14	0.07	0.10	0.01	0.07
(23)			Diff.	(15)-(19)	0.09	0.09	0.08	-0.21	-0.01
(24)			Sig.					***	
(25)	Part vs. not-part	Endline vs. Baseline	Project	(9)-(21)	0.03	0.08	0.12	0.26	0.16
(26)			Control	(10)-(22)	-0.06	0.04	0.13	-0.1	0.08
(27)			Diff.	(11)-(23)	0.09	0.04	0.01	0.36	0.08
(28)			Sig.					***	

Notes: Estimates for 270 farmers in 15 project villages and 333 farmers from 18 control villages. We only use farmers that participate in both surveys. *, **, ***, indicates p-value<0.10, p-value<0.05, and p-value<0.01, respectively. P-values are estimated using standard errors clustered at the village level. Estimates of α_5 from the model (2) are shown in row 27.

Table 4.7: Soybean production, consumption and sales in project and control villages by FFBS participation

					(1) Prod. Yes=1No=0	(2) Prod. Acre	(3) Prod. Kg	(4) Prod. Kg ihs	(5) Cons. Yes=1, No=0	(6) Cons. kg	(7) Cons. Kg ihs	(8) Sales Yes=1, No=0	(9) Sales Kg	(10) Sales Kg lhs.	(11) Price TZS/kg	(12) Price TZS/kg Ihs.	(13) Coll. sales Yes=1, No=0	(14) Sales rev. TZS	(15) Sales rev. TZS,ihs
(1)	FFBS Participant	End.	Project	Mean	0.53	0.18	36.44	1.88	0.44	10.81	1.40	0.16	8.69	0.66	226.18	1.24	0.29	12262.09	1.73
(2)			Control	Mean	0.07	0.03	5.24	0.31	0.04	0.27	0.10	0.04	1.31	0.16	80.81	0.31	0.07	2909.09	0.44
(3)			Diff.	(1)-(2)	0.46	0.15	31.20	1.57	0.40	10.54	1.30	0.12	7.38	0.51	145.37	0.94	0.22	9353.00	1.29
(4)			Sig.		***	***	***	***	***	***	**	***	**	**		**	**	**	**
(5)		Bas.	Project	Mean	0.05	0.02	2.39	0.09	0.03	0.23	0.03	0.02	3.59	0.10	31.00	0.13	0.02	6837.94	0.21
(6)			Control	Mean	0.07	0.06	13.57	0.36	0.05	3.57	0.24	0.07	9.29	0.38	57.14	0.53	0.14	6369.05	0.85
(7)			Diff.	(5)-(6)	-0.02	-0.04	-11.17	-0.27	-0.02	-3.34	-0.20	-0.05	-5.70	-0.28	-26.14	-0.40	-0.12	466.89	-0.64
(8)			Sig.																
(9)		End. vs Bas.	Project	Mean	0.48	0.16	34.05	1.79	0.41	10.58	1.37	0.14	5.10	0.56	195.18	1.11	0.27	5424.15	1.52
(10)			Control	Mean	0.00	-0.03	-8.33	-0.05	-0.01	-3.30	-0.14	-0.03	-7.98	-0.22	23.67	-0.22	-0.07	-3459.96	-0.41
(11)			Diff.	(3)-(7)	0.48	0.19	42.38	1.84	0.42	13.88	1.50	0.17	13.08	0.79	171.51	1.34	0.34	8886.11	1.93
(12)			Sig.		***	***	***	***	***	***	***	***		***	**	***	***		***
(13)	Not FFBS Participant	End.	Project	Mean	0.15	0.04	6.01	0.48	0.14	2.36	0.42	0.06	2.72	0.25	89.27	0.48	0.11	3256.41	0.68
(14)			Control	Mean	0.01	0.01	1.57	0.04	0.01	0.22	0.03	0.00	0.25	0.02	9.99	0.03	0.01	2338.13	0.05
(15)			Diff.	(13)-(14)	0.13	0.03	4.44	0.44	0.13	2.13	0.39	0.06	2.47	0.23	79.28	0.44	0.10	918.28	0.63
(16)			Sig.		***	***	**	***	***	**	***	**	*	**	*	**	**		**
(17)		Bas.	Project	Mean	0.01	0.01	0.07	0.02	0.01	0.07	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
(18)			Control	Mean	0.03	0.02	3.14	0.10	0.00	0.07	0.01	0.02	3.67	0.12	15.12	0.15	0.03	2482.82	0.25
(19)			Diff.	(17)-(18)	-0.02	-0.01	-3.07	-0.08	0.01	0.00	0.01	-0.02	-3.67	-0.12	-15.12	-0.15	-0.03	-2482.82	-0.25
(20)			Sig.																
(21)		End. vs. Bas.	Project	Mean	0.14	0.03	5.94	0.46	0.13	2.29	0.40	0.06	2.72	0.25	89.27	0.48	0.11	3256.41	0.68
(22)			Control	Mean	-0.02	-0.01	-1.57	-0.06	0.01	0.15	0.02	-0.02	-3.42	-0.10	-5.13	-0.12	-0.02	-144.69	-0.2
(23)			Diff.	(15)-(19)	0.15	0.04	7.51	0.52	0.12	2.13	0.38	0.08	6.14	0.35	94.40	0.59	0.13	3401.10	0.88
(24)			Sig.		***	**	**	***	***	**	***	**	**	**	**	**	**		**
(25)	FFBS participant vs non participants	End. vs. Bas.	Project	(9)-(21)	0.34	0.13	28.11	1.33	0.28	8.29	0.97	0.08	2.38	0.31	105.91	0.63	0.16	2167.74	0.84
(26)			Control	(10)-(22)	0.02	-0.02	-6.76	0.01	-0.02	-3.45	-0.16	-0.01	-4.56	-0.12	28.80	-0.10	-0.05	-3315.27	-0.21
(27)			Diff.	(11)-(23)	0.33	0.15	34.87	1.32	0.30	11.74	1.13	0.09	6.94	0.43	77.11	0.73	0.21	5485.01	1.05
(28)			Sig.		***	***	***	***	***	***	***	**		*		**	**		**

Notes: Estimates for 270 farmers in 15 project villages and 333 farmers from 18 control villages. We only use farmers that participate in both surveys. *, **, ***, indicates p-value<0.10, p-value<0.05, and p-value<0.01, respectively. P-values are estimated using standard errors clustered at the village level. Estimates of α_5 from the model (2) are shown in row 27.

4.3.2 VSLA impact pathway

We first test whether VSLA members from project villages are more likely to adopt agricultural technologies (Table 4.8). Estimates of α_5 from the model (3) are shown in row 27 of Table 4.8.

For VSLA members, when we compare the project and control farmers, the results in rows 1 to 3 show that the project intervention has significantly improved the adoption of manure composting, crop rotation, and the use of rhizobium inoculation during the 2019-2020 cropping season ($p<0.05$). The practices' adoption rates were similar in both project and control villages in the baseline cropping season (rows 5-7). The difference in differences analysis (rows 9-11) reveals that the project has doubled the adoption of crop rotation ($p<0.10$) and inoculation ($p<0.01$) technologies. The difference in differences analysis for non-VSLA members (rows 21-23) reveals that the project also has doubled the adoption of mulching ($p<0.05$), manure composting ($p<0.10$) and crop rotation technologies ($p<0.10$).

We find that intercropping and inoculation adoption is high for the farmers in project villages and members of VSLA. Farmers from project villages who are also members of VSLAs are 19 percentage points more likely to adopt intercropping ($p<0.1$) and eight percentage points more likely to adopt inoculation ($p<0.1$) when compared to other farmers (rows 25-27).

Second, we test whether VSLA members from the project villages have higher soybean production, consumption, and sales (Table 4.9) when compared to control villages. The results in rows 1-3 and rows 13-15 show that the project has increased soybean adoption for both VSLA members (rows 1-3) and non-VSLA members (rows 13-15) in the 2019-2020 cropping season when we compare the project to the control farmers ($p<0.01$). This holds for the number of farmers producing soybeans, the area under soybean production, and soybean yield per unit area. This, in turn, has facilitated an increase in the average amount of soybean consumed and sold. As a result, the project has led to a significant improvement in the soybean sales revenue for both VSLA and non-VSLA members, according to ihs transformed sales revenues.

In the baseline cropping season, soybean production and consumption were similar for both the VSLA members (rows 5-7) and non-VSLA members (rows 17-19). However, the difference in differences analysis shows that the FFBS+VSLA approach significantly ($p<0.01$) increased the adoption of soybeans (as well as the area under production, yield per unit area, consumption and sales, and the sales revenue) for both VSLA and non-VSLA members. However, the effect of FFBS+VSLA is more pronounced for VSLA members. Farmers from project villages who are members of a VSLA are more likely to adopt soybean production (17%-points, rows 25-27, $p<0.05$) than farmers from project villages but not members of VSLAs. As a result, the project village farmers who are also members of VSLAs (at $p<0.1$) have a higher increase in the area under soybean production, the amount of soybean consumed and sold, the price per unit of soybean and the sale revenues when compared to farmers who are from project village but not members of VSLA.

We also test whether the influence of VSLA membership results from the use of saving or loans for farms. Farmers from project villages and use VSLA loans for farms are more likely to adopt CSA practices than those from project villages but not using the VSLA loans for farms, as shown by the statistically significant estimate (see EndlineXProjectX Loan_farm use in Table A1 of Appendix B). We do not detect a statistically significant difference between the adoption rates of farmers from project villages who use and do not use savings in VSLAs to finance farming activities (Table A2 of Appendix B).

Overall, these results imply that the VSLA impact pathway of the FFBS+VSLA approach is complementary. The effect of the approach is higher for the farmers who are a member of a VSLA and use loans to finance farm investments.

Table 4.8: Agricultural practices in project and control villages by VSLA membership

					(1) Mulching Yes=1, No=0	(2) Manure composting Yes=1, No=0	(3) Crop rotation Yes=1, No=0	(4) Intercropping Yes=1, No=0	(5) Inoculation Yes=1, No=0
(1)	VSLA member	Endline	Project	Mean	0.32	0.82	0.43	0.61	0.19
(2)			Control	Mean	0.22	0.65	0.33	0.51	0.08
(3)			Diff.	(1)-(2)	0.10	0.17	0.10	0.09	0.11
(4)			Sig.			***	**		***
(5)		Baseline	Project	Mean	0.07	0.60	0.11	0.63	0.00
(6)			Control	Mean	0.10	0.53	0.16	0.60	0.00
(7)			Diff.	(5)-(6)	-0.03	0.07	-0.06	0.03	0.00
(8)			Sig.						
(9)		Endline vs. Baseline	Project	Mean	0.25	0.22	0.32	-0.02	0.19
(10)			Control	Mean	0.12	0.12	0.17	-0.09	0.08
(11)			Diff.	(3)-(7)	0.13	0.10	0.16	0.06	0.11
(12)			Sig.				*		***
(13)	Not VSLA member	Endline	Project	Mean	0.30	0.67	0.32	0.56	0.12
(14)			Control	Mean	0.18	0.64	0.24	0.58	0.08
(15)			Diff.	(13)-(14)	0.12	0.04	0.08	-0.02	0.04
(16)			Sig.		***				
(17)		Baseline	Project	Mean	0.05	0.51	0.11	0.64	0.00
(18)			Control	Mean	0.05	0.57	0.14	0.54	0.00
(19)			Diff.	(17)-(18)	-0.01	-0.06	-0.03	0.10	0.00
(20)			Sig.		-	-	-	**	
(21)		Endline vs. Baseline	Project	Mean	0.25	0.17	0.21	-0.08	0.12
(22)			Control	Mean	0.13	0.07	0.10	0.04	0.08
(23)			Diff.	(15)-(19)	0.12	0.10	0.11	-0.12	0.04
(24)			Sig.		**	*	*		
(25)	VSLAs vs. not-VSLA	Endline vs. Baseline	Project	(9)-(21)	0.00	0.05	0.11	0.06	0.07
(26)			Control	(10)-(22)	-0.01	0.05	0.06	-0.13	-0.01
(27)			Diff.	(11)-(23)	0.01	0.00	0.05	0.19	0.08
(28)			Sig.					*	*

Notes: Estimates for 270 farmers in 15 project villages and 333 farmers from 18 control villages. We only use farmers that participate in both surveys. *, **, ***, indicates p-value<0.10, p-value<0.05, and p-value<0.01, respectively. P-values are estimated using standard errors clustered at the village level. Estimates of α_5 from the model (3) are shown in row 27.

Table 4.9: Soybean production, consumption and sales in project and control villages by VSLA membership

					(1) Prod. Yes=1 No=0	(2) Prod. Acre	(3) Prod. Kg	(4) Prod. Kg ihs	(5) Cons. Yes=1, No=0	(6) Cons. kg	(7) Prod. Kg ihs	(8) Sales Yes=1, No=0	(9) Sales Kg	(10) Sales Kg lhs.	(11) Price TZS/kg	(12) Price TZS/kg lhs.	(13) Coll. sales Yes=1, No=0	(14) Sales rev. TZS	(15) Sales rev. TZS,ihs
(1)	VSLA	End.	Project	Mean	0.46	0.15	28.37	1.90	0.40	9.00	1.26	0.17	9.48	0.72	236.58	1.29	0.31	12,701	1.87
(2)	mem		Control	Mean	0.03	0.01	4.88	0.15	0.02	0.19	0.06	0.02	0.99	0.09	48.81	0.16	0.04	7,757	0.23
(3)			Diff.	(1)-(2)	0.43	0.14	23.49	1.75	0.38	8.81	1.20	0.15	8.48	0.63	187.77	1.13	0.27	4,944	1.63
(4)			Sig.		***	***	**	***	***	***	***	***	***	***	***	***	***		
(5)		Bas.	Project	Mean	0.02	0.01	0.37	0.05	0.02	0.36	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
(6)			Control	Mean	0.02	0.02	1.77	0.08	0.00	0.00	0.00	0.02	1.77	0.08	10.29	0.11	0.02	1,235	0.18
(7)			Diff.	(5)-(6)	0.01	-0.01	-1.41	-0.03	0.02	0.36	0.05	-0.02	-1.77	-0.08	-10.29	-0.11	-0.02	-1,235	-0.18
(8)			Sig.														0.299		
(9)		End. vs.	Project	Mean	0.44	0.14	28	1.85	0.38	8.64	1.21	0.17	9.48	0.72	236.58	1.29	0.31	12,700	1.87
(10)		Bas.	Control	Mean	0.01	-0.01	3.11	0.07	0.02	0.19	0.06	0.00	-0.78	0.01	38.52	0.05	0.02	6,522	0.05
(11)			Diff.	(3)-(7)	0.42	0.15	24.9	1.78	0.36	8.45	1.15	0.17	10.25	0.71	198.07	1.24	0.29	6,179	1.81
(12)			Sig.		***	***	***	***	***	***	***	***	***	***	***	***	***		***
(13)	Not	End.	Project	Mean	0.27	0.09	18.14	1.09	0.23	5.30	0.69	0.07	2.73	0.25	98.77	0.53	0.11	4,019	0.68
(14)	VSLA		Control	Mean	0.02	0.01	0.9	0.08	0.01	0.25	0.04	0.00	0.16	0.02	9.83	0.04	0.01	354	0.05
(15)	mem.		Diff.	(13)-(14)	0.25	0.08	17.24	1.01	0.22	5.05	0.65	0.06	2.57	0.23	88.93	0.49	0.10	3,665	0.63
(16)			Sig.		***	***	***	***	***	***	***	***	***	***	***	***	***	*	***
(17)		Bas.	Project	Mean	0.03	0.01	1.54	0.06	0.02	0.05	0.02	0.01	2.47	0.07	22.53	0.09	0.02	5,242	0.15
(18)			Control	Mean	0.04	0.03	5.15	0.17	0.01	0.64	0.05	0.03	5.02	0.17	22.45	0.22	0.06	3,419	0.37
(19)			Diff.	(17)-(18)	-0.01	-0.02	-3.61	-0.10	0.01	-0.59	-0.03	-0.02	-2.58	-0.1	0.07	-0.13	-0.04	1,823	-0.22
(20)			Sig.		0.80												0.191		
(21)		End. vs.	Project	Mean	0.24	0.08	16.6	1.03	0.21	5.25	0.67	0.06	0.26	0.18	76.24	0.44	0.10	-1,223	0.53
(22)		Bas.	Control	Mean	-0.02	-0.02	-4.25	-0.09	0.00	-0.39	-0.01	-0.03	-4.86	-0.15	-12.62	-0.18	-0.05	-3,065	-0.32
(23)			Diff.	(15)-(19)	0.26	0.1	20.85	1.11	0.21	5.64	0.68	0.08	5.15	0.33	88.86	0.62	0.14	1,842	0.85
(24)			Sig.		***	***	***	***	***	***	***	***		***	***	***	***		***
(25)	VSLA	End. vs.	Project	(9)-(21)	0.20	0.06	11.4	0.82	0.17	3.39	0.54	0.11	9.22	0.54	160.34	0.85	0.22	13,924	1.34
(26)	vs.	Bas.	Control	(10)-(22)	0.03	0.01	7.36	0.16	0.02	0.58	0.07	0.03	4.08	0.16	51.14	0.23	0.07	9,587	0.37
(27)	not-		Diff.	(11)-(23)	0.17	0.05	4.05	0.67	0.15	2.81	0.47	0.08	5.14	0.38	109.21	0.62	0.15	4,338	0.96
(28)	VSLA		Sig.		**	*		**	***		**	*		*		*	*		*

Notes: Estimates for 270 farmers in 15 project villages and 333 farmers from 18 control villages. We only use farmers that participate in both surveys. *, **, ***, indicates p-value<0.10, p-value<0.05, and p-value<0.01, respectively. P-values are estimated using standard errors clustered at the village level. Estimates of α_5 from the model (3) are shown in row 27.

4.3.3 Women’s empowerment impact pathway

Finally, we examine how the effect of FFBS+VSLA on the adoption of CSA practices changes by the level of women’s in agriculture. Our results in Tables 4.10a and 4.10b provide some evidence on this. We find that farming households in project villages have higher soybean production and consumption outcomes when the women in the households are empowered (estimates for "EndlineXProjectXWomen’s empowerment" in columns (6) and (9) of Table 4.10a and Columns (1), (2), and (3) of Table 4.10b.

These results on women’s empowerment align with the theory of change of the FFBS+VSLA approach. Our estimates show that a seven percentage point increase in the women’s empowerment score - equivalent to the effect of the FFBS+VSLA approach (see column 11 of Table 4.4) - enhances the FFBS+VSLA approach’s effect on the likelihood of producing soybean by 2.1 percentage points. This implies that women can more easily access resources and information on new agricultural practices in households with a higher women's empowerment score. They also have more influence on farm decisions to produce more soybean.

The increased soybean production facilitated by women’s empowerment is also translated into increased soybean consumption. A 7 percentage point increase in the empowerment score enhances the FFBS+VSLA approach effect on soybean consumption by 0.7 kg per household. This implies that women’s empowerment also enhances the effect of the FFBS+VSLA approach on the nutritional wellbeing of households, and women use their knowledge on nutrition benefits of soybean consumption for improving the nutrition in the households.

Table 4.10a: Regression estimation results for women's empowerment in use of agricultural practices and soybean production

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Mulching	Manure composting	Crop rotation	Intercrop.	Rhizobium ino.	Prod.	Prod.	Prod.	Prod.
	Yes=1, No=0	Yes=1No=0	Yes=1 No=0	Yes=1, No=0	Yes=1, No=0	Yes=1, No=0	Acre	Kg	Kg, ihs
Constant	0.07**	0.53***	0.12**	0.28***	4.65e-15***	0.05	0.05	5.73	0.19
	(0.031)	(0.09)	(0.06)	(0.08)	(3.24e-09)	(0.04)	(0.04)	(5.10)	(0.15)
Endline	0.3***	0.118	0.058	0.137	0.11	-0.02	-0.02	-0.46	-0.01
	(0.070)	(0.11)	(0.09)	(0.12)	(0.04)	(0.05)	(0.05)	(7.30)	(0.22)
Project	0.012	-0.148	-0.033	-0.013	-3.59e-15	-0.02	-0.04	-5.18	-0.14
	(0.051)	(0.13)	(0.08)	(0.12)	(7.64e-09)	(0.06)	(0.04)	(5.15)	(0.17)
Women's empowerment	-0.016	0.055	0.039	0.42***	-6.54e-15	-0.03	-0.04	-1.93	-0.06
	(0.040)	(0.11)	(0.08)	(0.102)	(4.51e-09)	(0.05)	(0.05)	(5.60)	(0.17)
EndlineXProject	-0.047	0.136	0.080	-0.052	0.073	0.12	0.04	10.26	0.37
	(0.128)	(0.14)	(0.14)	(0.16)	(0.07)	(0.09)	(0.06)	(14.72)	(0.45)
Endline X Women's empowerment	-0.26**	-0.062	0.112	-0.191	-0.046	0.01	0.01	-3.03	-0.07
	(0.101)	(0.15)	(0.13)	(0.16)	(0.06)	(0.07)	(0.06)	(8.16)	(0.27)
ProjectX Women's empowerment	-0.026	0.165	-0.008	0.103	5.01e-15	0.03	0.04	2.79	0.08
	(0.057)	(0.15)	(0.09)	(0.15)	(8.95e-09)	(0.07)	(0.05)	(5.65)	(0.22)
EndlineXProjectXWomen's empowerment	0.269	-0.004	0.061	-0.017	0.004	0.30**	0.12	19.68	1.52**
	(0.160)	(0.18)	(0.195)	(0.211)	(0.10)	0.14	(0.08)	(19.37)	(0.66)
N	1206	1206	1206	1206	1206	1206	1206	1206	1206

Notes: This table reports the estimate from model 4. *, **, ***, indicates p-value<0.10, p-value<0.05, and p-value<0.01, respectively. P-values are estimated using standard errors clustered at village level.

Table 4.11b: Regression estimation results for women's empowerment in soybean consumption and sales

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
	Cons.	Cons.	Prod	Sales	Sales	Sales	Price	Price	Coll. sales	Sales rev.	Sales rev.
	Yes=1, No=0	kg	Kg, ihs	Yes=1, No=0	Kg	Kg lhs.	TZS/kg	TZS/kg, ihs	Yes=1, No=0	TZS	TZS, ihs
Constant	0.004	0.19	0.02	0.03	5.83	0.19	25.24	0.24	0.06	4108	0.40
	(0.003)	(0.17)	(0.01)	(0.03)	(5.02)	(0.15)	(19.38)	(0.18)	(0.05)	(3523)	(0.31)
Endline	0.02	0.68	0.09	-0.02	-5.04	-0.13	7.72	-0.15	-0.04	4107	-0.25
	(0.02)	(0.72)	(0.07)	(0.03)	(5.14)	(0.16)	(41.39)	(0.22)	(0.06)	(9454)	(0.37)
Project	0.02	-0.47*	-0.07*	-0.02	-3.15	-0.11	-5.38	0.14	-0.04	66.93	-0.23
	(0.03)	(0.28)	(0.04)	(0.03)	(5.42)	(0.16)	(23.72)	(0.20)	(0.05)	(4493)	(0.34)
Women's empowerment	0.01	0.48	0.04	-0.01	-2.20	-0.05	-7.98	-0.07	-0.03	-1717	-0.12
	(0.01)	(0.46)	(0.03)	(0.03)	(5.38)	(0.18)	(25.30)	(0.23)	(0.06)	(3772)	(0.39)
EndlineXProject	0.05	-0.05	0.14	0.07	13.75	0.32	149.92	0.60	0.17	10867	0.83
	(0.08)	3.51	(0.29)	(0.06)	(11.87)	(0.29)	(108.13)	(0.45)	(0.11)	(17677)	(0.69)
Endline X Women's empowerment	-0.03	-1.51	-0.13	0.01	1.62	0.03	-9.02	0.04	0.02	-8017	0.05
	(0.02)	(0.95)	(0.09)	(0.04)	(5.43)	(0.19)	(54.99)	(0.27)	(0.07)	(10997)	(0.44)
ProjectX Women's empowerment	-0.01	0.11	0.07	0.001	0.83	0.01	1.88	0.01	0.01	926	0.01
	(0.05)	(0.66)	(0.08)	(0.03)	(5.72)	(0.19)	(28.29)	(0.25)	(0.06)	(4616)	(0.41)
EndlineXProjectXWomen's empowerment	0.32***	10.13**	1.10**	0.08	-7.42	0.30	1.75	0.49	0.08	-6646	0.76
	(0.11)	(4.83)	(0.41)	(0.08)	(14.14)	(0.41)	(139.25)	(0.65)	(0.16)	(2098)	(0.99)
N	1206	1206	1206	1206	1206	1206	1206	1206	1206	1206	1206

Notes: This table reports the estimate from model 4. *, **, ***, indicates p-value<0.10, p-value<0.05, and p-value<0.01, respectively. P-values are estimated using standard errors clustered at village level.

5 Conclusions and policy implications

The FFBS+VSLA intervention was successful in training farming households in CSA practices as well as business practices. The participation rates in the project villages were substantial, varying between 38% and 54%, depending on the training topic. The training changed some business practices of farmers, particularly farm record keeping and the collective purchase of inputs. This shows that the FFBS+VSLA model is an effective platform also for training on farmer business practices. The FFBS+VSLA intervention also contributed positively to women's leadership roles, measured by the women's membership in socioeconomic groups. Throughout the project, women's membership in the socioeconomic group increased more in project villages than in control villages. No effect could be measured on the women's control over income, resources, and production.

The membership of VSLAs increased from 20-30% to 30-50%. It is plausible that the project had a positive effect on this. The annual savings amounts per VSLA member grew, partly as an effect of the trainings, from an average of 15-19 US$ per member to 27-45 US$. Similarly, the annual loans per VSLA member increased from an average of 14-16 US$ to 24-36 US$. Some of these savings and loans were used for investments in farming or other business activities.

It proved to be possible to enhance the adoption rates of CSA practices during the project. After the project, the adoption rate of CSA practices, including mulching, manure composting, crop rotation and rhizobium inoculation, increased. The FFBS+VSLA intervention had a positive effect on these changes. Intercropping lost traction among the farmers, possibly because it proved to be more labour-intensive and less economically viable than crop rotation (Ng'ang'a et al., 2020).

Also, the adoption of soybeans as a soil-enriching and nutritious crop increased in the project. More farmers started cultivating soybeans, from 3% at baseline to 36% at endline in the project villages, and the average acreage grew from garden scale to roughly one-third of an acre. Most farmers producing soybeans also consumed them in their families, and about one-third of them also sold a small quantity on the market. In the long term, we expect that soil-enriching characteristics of soybean will also positively contribute to the overall productivity of other crops (e.g., maize) as farmers use crop-rotation of soybean with other crops.

The linkage with VSLAs reinforces the effectiveness of the FFBS. The VSLA members in the project villages show a higher CSA adoption than non-members, specifically in intercropping and rhizobium inoculation. Similarly, they also show higher production, consumption, and sales of soybean than non-VSLA members. This impact pathway is more pronounced for farmers that use loans from VSLAs to finance farming activities.

When households have a high degree of women's empowerment, as witnessed by a high WEAI score, this results in better CSA adoption performance. This is the case for the adoption of soybean, both on the production and the consumption side, and can be understood because women who are empowered in the household have better access to resources and information and decision making capacity on new agricultural practices. Women who are powerful in decision making and trained by the project on the nutritional benefits of soybean provided nutritious soybean meal to the family.

FFBS+VSLA approach of combining farmer training, microfinance, and women's empowerment had positive effects on adopting CSA practices within the project period of two growing seasons. The set of interventions (i.e., credit, savings, training on CSA practices and soybean production) represent important assets in a small-scale subsistence economy where food and nutrition security and resilience are key priorities. Furthermore, the sales of soybean through collective sales might open a new trajectory for farmers to start aggregating their produce and sell it commercially. For policymakers, this implies that it may make sense to replicate this model in a quest to achieve similar effects elsewhere and at a larger scale. Specific attention is needed on two points. First, all efforts for increased women's empowerment are an essential condition to ensure that they benefit equally from the potential of CSA adoption. Second, special attention to the functioning of VSLA should also be given as the loans from VSLAs used for farming investments stimulate the investment in CSA practices.

Further research is needed to confirm whether the effects are lasting in a longer time horizon, without additional external resources or repeated trainings or coaching. Also, it would require further research to explore the funding base for the replication of this model. So far, the FFBS+VSLA intervention in Iringa is not based on a profitable business model that could make the replication commercially scalable. Therefore the replication requires public resources or sponsorships, which makes it dependent on external support. Such sponsorships may not necessarily originate only from governments, NGOs, and donors. They may also include sponsorships from the private sector, such as agribusiness companies interested in making social investments in their supply chains or needed to make greening investments, to meet industry standards, government regulations or nationally determined contributions to the Paris Agreements. Or they may include contributions from climate funds who prioritize adaptation and mitigation measures, also for farmers operating outside commercial commodity value chains. With those public resources or public or private sponsorships, the approach can be used by government, NGOs, private sector to upscale the adoption of CSA practices at a larger scale.

Appendix A: Construction of gender indicators

All five indicators score between 0 and 1, whereby 1 reflects a high gender equity within the household. We assume high gender equity when the primary adult female had sole or joint control over resources or decision-making (or according to other WEAI guidelines). Some important notes for indicators by domain is as follows:

Production domain: The Production domain is based on three indicators reflecting decisions about inputs and practices used as well as farm products.

Resources domain: We use major household assets to measure resources empowerment using the following criteria: a) if they were owned by at least 200 households and b) if at least 30% of the households that owned them also believed that they were useful for coping against shocks. This eliminated the least useful assets from the analysis (e.g. DVD players) and reduced the resources to radios, phones, sprayers, kraals, storage facilities and chickens.

Income domain: It is the average of ten indicators measuring control over a) revenues and b) expenditures. For example, it reflects who decides how to spend the income from cash crops or who receives the income from the sale of small livestock.

Leadership domain: We use three indicators indicating whether women are members of at least one socioeconomic group. These three indicators consider the fact that household members are found to be part of as many as three groups.

Appendix B: Additional tables

Table A.1: Regression estimates for the effect of FFBS+VSLA approach on CSA practices by use of VSLA loan for farm use

	Intercropping	Inoculation	Prod.	Prod.	Prod.	Cons.	Cons.	Sales	Sales	Price	Coll. sales	Sales revenue
	Yes=1, No=0	Yes=1, No=0	Yes=1, No=0	Acre	Kg	Yes=1, No=0	Kg	Yes=1, No=0	Kg	TZS/kg	Yes=1, No=0	TZS
Constant	0.55***	3.19e-16	0.03**	0.02*	4.66*	0.01	0.57	0.03**	4.49*	19.97**	0.05*	3040.27*
	(0.03)	(7.63e-10)	(0.02)	(0.01)	(2.68)	(0.01)	(0.51)	(0.01)	(2.50)	(9.50)	(0.03)	(1699.84)
Endline	0.01	0.08***	-0.01	-0.01	-2.38	0.004	-0.33	-0.02	-4.11	-1.25	-0.04	-65.36
	(0.05)	(0.02)	(0.02)	(0.01)	(3.04)	(0.01)	(0.53)	(0.01)	(2.49)	(15.12)	(0.02)	(3267.63)
FFBS	0.09**	-3.18e-16	-0.003	-0.01	-3.23	0.01	-0.39	-0.02	-2.51	-1.90	-0.04	1162.32
	(0.04)	(6.29e-10)	(0.02)	(0.01)	(2.93)	(0.01)	(0.52)	(0.01)	(2.83)	(16.19)	(0.03)	(3622.06)
EndlineXFFBS	-0.09	0.05	0.31***	0.11***	20.61***	0.25***	6.13***	0.10***	5.48*	118.35***	0.19***	337.54
	(0.07)	(0.03)	(0.49)	(0.02)	(4.56)	(0.04)	(1.13)	(0.03)	(3.06)	(38.55)	(0.05)	(4881.82)
Loan_farm use	0.05	-9.77e-17	-0.005	0.01	-1.23	-0.01	-0.57	0.002	-1.06	0.03	-0.02	-640.27
	(0.10)	(8.29e-10)	(0.02)	(0.02)	(3.80)	(0.01)	(0.51)	(0.02)	(3.20)	(15.66)	(0.03)	(2276.21)
Endline X Loan_farm use	-0.05	-0.01	0.002	-0.01	0.62	0.01	0.52	0.01	1.34	22.40	0.04	-853.16
	(0.11)	(0.04)	(0.04)	(0.03)	(5.02)	(0.02)	(0.71)	(0.03)	(3.50)	(45.79)	(0.05)	(4202.46)
FFBS X Loan_farm use	-0.12	8.13e-17	0.001	-0.01	-0.19	0.01	0.39	-0.01	-0.92	-18.09	0.01	-3562.32
	(0.13)	(7.59e-10)	(0.04)	(0.03)	(3.98)	(0.03)	(0.52)	(0.02)	(3.47)	(20.43)	(0.03)	(3925.69)
EndlineXFFBSX Loan_farm use	0.21	0.13*	0.19**	0.07*	21.78**	0.19**	5.76	0.14**	14.90*	164.43	0.21**	25227.13**
	(0.16)	(0.07)	(0.09)	(0.04)	(10.57)	(0.09)	(3.85)	(0.06)	(7.72)	(106.59)	(0.10)	(11083.24)
N	1206	1206	1206	1206	1206	1206	1206	1206	1206	1206	1206	1206

Table A.2: Regression estimates for the effect of FFBS+VSLA approach on CSA practices by use of VSLA savings for farm use

	Intercropping	Inoculation	Prod.	Prod.	Prod.	Cons.	Cons.	Sales	Sales	Price	Coll. sales	Sales revenue
	Yes=1, No=0	Yes=1, No=0	Yes=1, No=0	Acre	Kg	Yes=1, No=0	Kg	Yes=1, No=0	Kg	TZS/kg	Yes=1, No=0	TZS
Constant	0.55***	3.12e-16	0.04**	0.02*	4.88*	0.01	0.59	0.03*	4.69*	20.88**	0.05*	3178.95*
	(0.03)	(NA)	(0.02)	(0.01)	(2.82)	(0.01)	(0.53)	(0.01)	(2.63)	(10.00)	(0.03)	(1785.55)
Endline	0.01	0.07***	-0.02	-0.01	-2.72	0.004	-0.35	-0.02	-4.29	-1.54	-0.04	-104.87
	(0.05)	(0.02)	(0.02)	(0.02)	3.13	(0.01)	(0.55)	(0.01)	(2.61)	(15.48)	(0.03)	(3352.18)
FFBS	0.09**	-2.58e-16	-0.01	-0.01	-3.50	0.01	-0.55	-0.02	-2.58	-1.57	-0.04	1314.14
	(0.04)	(NA)	(0.02)	(0.01)	(3.08)	(0.01)	(0.53)	(0.02)	(2.99)	(17.25)	(0.03)	(3861.91)
EndlineXFFBS	-0.06	0.04	0.30***	0.11***	21.77***	0.25***	6.49***	0.11***	7.72**	126.02***	0.21***	3303.81
	(0.07)	(0.03)	(0.04)	(0.02)	(4.29)	(0.04)	(1.27)	(0.03)	(3.71)	(36.42)	(0.05)	(5823.05)
VSLA farm savings	0.06	-2.69e-17	-0.01	-0.004	-2.38	-0.01	-0.59	-0.01	-2.19	-6.29	-0.03	-1428.95
	(0.08)	(NA)	(0.02)	(0.02)	(3.43)	(0.01)	(0.53)	(0.02)	(2.84)	(12.37)	(0.03)	(2000.99)
Endline X VSLA farm savings	-0.06	0.04	0.03	0.001	2.51	0.01	0.51	0.01	2.37	22.23	0.05	-375.29
	(0.09)	(0.04)	(0.03)	(0.02)	(4.49)	(0.02)	(0.71)	(0.03)	(3.06)	(37.77)	(0.05)	(3814.25)
FFBS X VSLA farm savings	-0.05	-2.57e-16	0.02	0.003	1.60	0.03	1.12	-0.002	0.08	-13.02	0.02	-3064.14
	(0.10)	(2.44e-09)	(0.04)	(0.02)	(3.69)	(0.03)	(0.74)	(0.02)	(3.17)	(18.72)	(0.03)	(3966.12)
EndlineXFFBSX VSLA farm savings	0.04	0.08	0.12	0.06	9.24	0.09	2.12	0.05	1.61	75.71	0.05	7066,59
	(0.14)	(0.06)	(0.07)	(0.03)	(9.83)	(0.07)	(3.18)	(0.05)	(4.87)	(66.24)	(0.08)	(7303.01)
N	1206	1206	1206	1206	1184	1206	1206	1206	1206	1206	1206	1206

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