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Impact evaluation of the Home Grown School Feeding and Conservation Agriculture Scale-up programmes in Zambia

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Abbreviations and acronyms

CA	Conservation Agriculture
CASU	Conservation Agriculture Scale-Up
CDDS	Children's Dietary Diversity Score
CT	Cash Transfer
EA	Enumeration Area
FAO	Food and Agriculture Organization of the United Nations
FIES	Food Insecurity Experience Scale
FNS	Food and Nutrition Security
FRA	Food Reserve Agency
GPS	Generalized propensity score
GRZ	Government of the Republic of Zambia
ha	hectares
HGSF	Home Grown School Feeding
HH	household
IFAD	International Fund for Agricultural Development
IPW	Inverse probability weighted (regression)
ITT	Intention to treat
MA	Market access
MDD-W	Minimum Dietary Diversity indicator for Women
MoA	Ministry of Agriculture
MoCD	Ministry of Community Development
MoFL	Ministry of Fisheries and Livestock
MoGE	Ministry of General Education
NFB	Non-farm business
P4P	Purchase for Progress
PFP	Public Food Procurement
SCT	Social Cash Transfer
SF	School Feeding
TLU	Tropical livestock unit
USD	United States Dollar
WDDS	Women's Dietary Diversity Score
WFP	World Food Programme
ZMK	Zambian Kwacha

Executive summary

Home Grown School Feeding (HGSF) is a school feeding programme that provides food produced and purchased within a country. Since 2011, Zambia's school feeding programme has gradually transitioned to an HGSF programme but it has never undergone a rigorous impact evaluation since its conception. Zambia's HGSF programme is currently managed and partly funded by the government and provides nutritious cooked meals to almost one million schoolchildren. The Conservation Agriculture Scale-Up (CASU) project started in 2013 and lasted 4.5 years up until late 2017. With coverage of 227 534 beneficiary follow farmers and some 20 000 lead farmers, the CASU project provided agronomic training, promoting conservation agriculture, extension support and farm inputs to increase productivity and production of crops for food security and income generation.

This impact evaluation of the HGSF programme and the CASU project has the objective of quantifying the effects of each programme in isolation and in combination with one another. We focus on three groups of outcomes: farm production and income-generating activities; food and nutrition security (FNS); and education outcomes. We illustrate the direct and indirect channels that link each component of the programmes to these outcomes in a dedicated section on the theory of change. The evaluation is based on a post-test only non-equivalent control group design with only one wave of post-intervention data. The household and community surveys for evaluation of the programmes were conducted between October 2017 and January 2018. The total sample size is 3 639 households and a total of 72 community interviews were also conducted.

Maize is the most widely grown crop in the CASU group (grown by 99.3% of farmers), the combined group (97.8%) and the control groups (93.3%). In the HGSF group, beans are the most widely grown crop, with 89.7 percent of the households growing some, while maize is only the second most grown crop, at 79.2 percent. In terms of relative importance within the crop portfolio, maize, beans and groundnuts are the most important crops regardless of the treatment group. The CASU programme is associated with an increase of 68 percent in the production of maize. In the HGSF programme, maize production is reduced by 643 kg on average, or 33 percent in relative terms, while sorghum production falls to zero from an average of 25 kg per household. For maize, the impact of the combined interventions amounts to an increase of 607 kg, which in relative terms translates to 31 percent.

The average herd size also increases by 0.5 tropical livestock units (TLUs) in the CASU-only arm. In the HGSF arm, we observe a reduction in the spread of livestock activities and in the average number of animals owned. The number of farmers dealing with livestock decreases by 23 percent while herd size reduces by 88 percent. The impacts in the combined arm are similar to those in the CASU-only arm, with even larger changes in the herd size, which expands by 102 percent.

The CASU programme is associated with an increase in the average revenues from maize market sales of 39 percent and a reduction in the average revenues from beans sales of 87 percent. Total crop revenues increased by almost 70 percent. The HGSF programme leads to an increase in revenues from the sale of beans and groundnuts. Specifically, we see that revenues from beans

increase by 2.3 times, relative to the control group, and those from groundnuts by 2.9 times. Total revenues from crop sales increase by almost 50 percent in this group. Results for the combined group show a similar pattern to that of the CASU-only group: a significant reduction in the revenues from beans sales (-71%) and an increase in the sales revenues from groundnuts (4.9 times). There are no impacts on maize sales. Total crop revenues almost double, putting the combined group at the top in terms of commercial benefits.

The HGSF programme leads to a reduction in total gross income of 40 percent. The combined treatment increases gross income by 42.8 percent. The CASU programme has no statistically significant impact on gross income but does lead to an increase in livestock income.

The CASU programme stimulates households' involvement in non-farm businesses (NFBs) and in paid work activities, while the HGSF programme and its combination with CASU is associated mostly with reduced engagement in NFBs and paid work. Around 98 percent of households are involved in farm labour in all groups. The cross-group pattern of impacts on farm labour supply points to a reduction in labour supply for the HGSF and combined treatment farmers, while CASU does not influence adult farm labour supply.

Crop cultivation is generally very little diversified in all four groups, with most of the farmers growing an average of two crops, one of which is usually maize. Both the standalone programmes and their combination lead to marginal increases in crop diversification.

Almost every household in the sample cultivates some land and the average area of operated land ranges between 3.2 and 5.8 hectares (ha). Neither of the programmes has impacts on the overall area of cultivated land. They do lead to reallocation of land among crops, however. CASU farmers increase the land dedicated to maize and reduce the areas under beans, cassava and sorghum. HGSF farmers favour beans in their land reallocation decisions at the expense of maize. Beneficiaries of the combined programmes reduce the area of land dedicated to maize and beans and increase allocations for soybeans and sunflowers.

Both the CASU programme and its combination with HGSF greatly stimulate the adoption of conservation agriculture (CA) practices across virtually all crops. Greater diffusion of these techniques is observed for maize and groundnuts. In terms of specific CA practices, the ones that are more widespread, and at the same time more stimulated by CASU, are zero tillage and leaving crop residues in the field.

School meals have a positive impact on the FNS indicators considered in the study. In particular, providing meals at schools improves the children's dietary diversity score (CDDS) by 60 percent. However, when considering the HGSF programme as a whole – i.e. as a combination of school meals and market access benefits – the impacts on FNS indicators become negative. The CASU programme is associated with improvement of both children's and women's dietary diversity and reduces the food insecurity indicator (FIES) for the household. The combined programmes also have positive effects on children's and women's dietary diversity.

Meals *per se* have a positive impact on schooling outcomes, increasing attendance rates and contributing to keep children in school from one year to the next, thus reducing the drop-out rate. When studying the HGSF programme as a whole, however, impacts on educational outcomes are nullified. CASU does not have significant impacts on the main schooling indicators for primary- or secondary-school children. The combination of programmes seems to have unintended detrimental effects on most schooling indicators, especially on attendance rates.

1. Introduction

This impact evaluation focuses on Zambia's Home Grown School Feeding (HGSF) programme, implemented by the government in collaboration with World Food Programme (WFP) and the Conservation Agriculture Scale-Up project implemented by the Food and Agriculture Organization of the United Nations (FAO) country office in Zambia. The report aims at quantifying the effects of each programme in isolation and in combination with one another. We focus on three groups of outcomes, namely: farm production and income- generating activities; food and nutrition security (FNS); and education outcomes. The evaluation is based on a post-test only non-equivalent control group design with only one wave of post-intervention data. The household and community surveys for the evaluation of the programmes took place between October 2017 and January 2018. The total sample size is 3 636 households and a total of 72 community interviews were also conducted.

School feeding (SF) programmes are well-recognized social protection interventions that aim to alleviate hunger while supporting education, food security and health. SF programmes exist in almost all high- and middle-income countries and are present in some 70 of 108 low- and lower-middle-income countries, typically with support from WFP. Some 368 million children in the world are fed daily at school through SF programmes that are run in varying degrees by national governments (FAO, 2018). Evidence on the impacts of SF programmes on pupils' nutrition and education and on their cost-effectiveness is relatively abundant (Alderman and Bundy, 2012; Gelli *et al.*, 2009; Jomaa *et al.*, 2011; Kristjansson *et al.*, 2007).

The WFP-supported School Meals Programme started in 2003 in Zambia, by providing a hot nutritious meal of High Energy and Protein Supplements to children enrolled and attending classes in targeted schools. In March 2011 this was transformed to maize meal, pulses and oil. Plans are underway to either fortify the maize meal or use micro-nutrient powders, which can be added to the meals after preparations.

HGSF is a SF programme that provides food produced and purchased within a country, to the extent possible. Since 2011 Zambia's SF programme has gradually transitioned to a HGSF programme. When SF programmes procure food locally they can stimulate local economic activity and agricultural production, by providing predictable demand and markets for agricultural produce for households in rural areas that often face constraints in accessing markets. The HGSF in Zambia uses WFP's Purchase for Progress (P4P) platform to procure the commodities that make up the school meal. The P4P is a pilot programme active in 35 countries that consists of purchasing staple food commodities (cereals, pulses and blended foods) from smallholders that are later distributed as food assistance in the country of purchase or worldwide. P4P promotes the development of agricultural markets so as to give smallholders the chance to sell food surpluses at a fair price and increase their incomes. In Zambia, the P4P programme is implemented in 24 districts across six of Zambia's ten provinces.[1] Through partnerships with non-governmental organizations and UN agencies such as FAO, P4P has

[1] Table 67 in the appendix shows the coverage by district of school meals and public food procurement under the HGSF programme. It also shows coverage of the CASU project. Figure 8 in the appendix shows a district map of Zambia illustrating the coverage of HGSF and CASU.

supported smallholder farmers to directly access commercial markets and sell aggregated quantities of crops to increase income.

Zambia's HGSF is currently managed and partly funded by the government, and provides nutritious cooked meals to almost one million schoolchildren. The food basket is limited to cereals, pulses and cooking oil, of which only pulses (beans and peas) are procured directly from Zambian farmers, oil being imported and cereals being bought from the Food Reserve Agency. See Appendix for more details on the coverage of programmes and of the study sample.[2]

The main goal of Zambia's HGSF program, as defined by the Revised Sixth National Development Plan, is to increase school attendance and retention for both boys and girls. The second goal, as defined by the National Food and Nutrition Strategic Plan, is to reduce rural poverty by improving local household economies and providing ready markets for local agriculture. The HGSF programme provides one hot meal per day to every child enrolled in pre-primary and primary schools in the targeted districts, throughout the school year. A single ration contains 120 g per child/day of maize and 60 g per child/day of pulses. School meals are provided through HGSF in 38 out of 105 districts, in all 10 provinces of Zambia. These districts were selected based on three educational and three economic indicators: drop-out rate; net enrolment ratio; completion rate; extreme poverty rate; access to arable land; and proportion of total farmer households. The HGSF is implemented in both public and community schools.[3] In 2016, the programme supported 977 000 beneficiaries in 2 591 schools (out of more than 8 800 schools), accounting for approximately 25 percent of all children enrolled in primary and pre-primary schools, with parity between boys and girls

In summary, HGSF combines the provision of school meals with the procurement, through P4P, of supplies for the school meals from local farmers. The programme has multiple aims – in addition to feeding children and encouraging them to attend school, it provides market access to smallholder farmers. The commodities are procured through the WFP's P4P platform based on the school enrolment numbers, ration size and number of feeding days. In 2016, only around 17 percent of P4P's purchases of pulses went to cover the demand coming from HGSF – namely 140 tonnes of beans (out of 2477 tonnes produced) and 663 tonnes of peas (out of 2217 tonnes produced). The share of P4P purchases earmarked for HGSF increased to around 35 percent in 2017; 1117 tonnes of beans (out of 3454 tonnes produced) and 991 tonnes of peas (out 2544 tonnes produced) went to cover HGSF. However, the share of HGSF is set to grow, as WFP is supporting the government in its goal of reaching two million children by 2020. The rest of the purchases through P4P cover in-kind transfers and represent another form of social protection. As of now, by seeking to offer a predictable and sustained income stream for HGSF suppliers, the local purchases through the P4P programme pursue mainly social protection objectives.

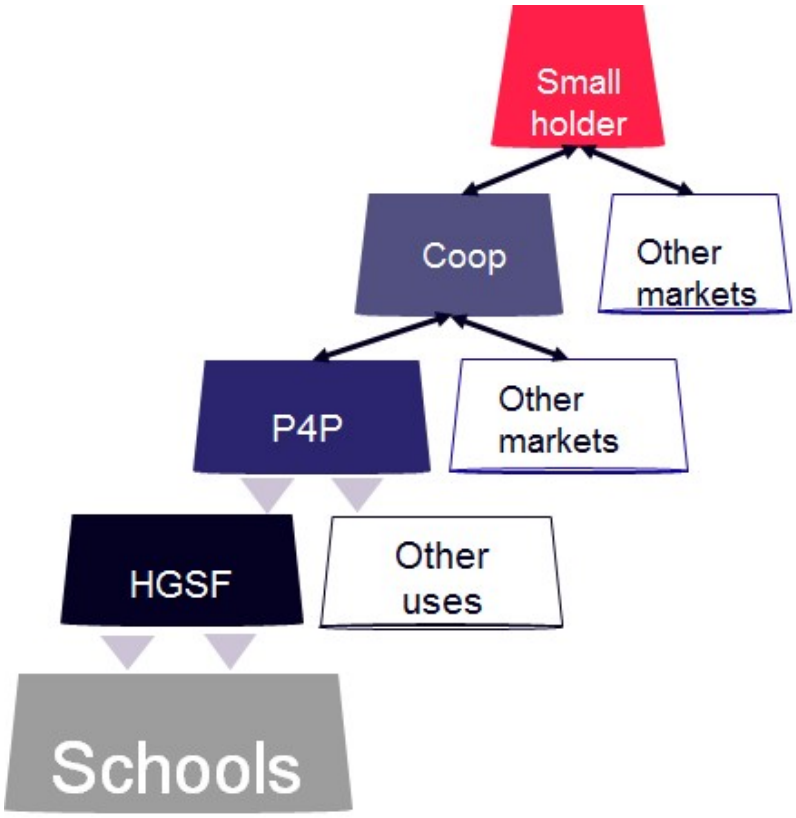
Aggregators have a central role in connecting smallholders to HGSF purchases. In some districts, farmers' cooperatives act as aggregators by buying the produce from their members, while in other districts, agrodealers buy the produce from local farmers. Both types of aggregators sell the collected

[2] In 20 schools of the country vegetables are also provided. Local procurement of vegetables is completely decentralized and each school procures the goods from local farmers. However, the implementation is still at an early stage.

[3] These schools are typically free, run by parents, and often have far fewer resources – from books to trained teachers – than Zambia's government-run and private schools.

produce in different markets, one of which is WFP's P4P platform, which in turn uses the purchased produce partly for HGSF and partly for in-kind assistance, either in Zambia or abroad. Hence, in the districts where cooperatives act as aggregators, a minimum eligibility criterion for smallholders to benefit from the HGSF purchases is membership in a farmers' cooperative. Cooperatives that apply for the programme are further selected by WFP based on the cooperative's self-reported storage capacity, size, services offered to members, assets owned and financial aspects. Figure 1 illustrates the food supply chain, whereby connectors indicate an exchange of goods for money when represented by double-headed arrows and allocations of crops to alternative uses when represented by triangles.

Figure 1: HGSF food supply chain



The Conservation Agriculture Scale-Up (CASU) project covered 31 districts, 11 of which were in common with HGSF. It was implemented by the Ministry of Agriculture (MoA) with the support of FAO. It aimed at improving conservation agriculture (CA) capacities by training lead and follow farmers on CA practices, mechanization and business management. Extension officers of the MoA were trained in these three areas and transferred the training to the lead farmers, who in turn passed it down to follow farmers. Farmer-led demonstration plots enabled practical training and demonstration. The final objectives were to reduce hunger and to improve food security and income by increasing crop production, diversification and productivity. CASU follows the three principles of CA, which has been shown to increase productivity, help to build resilience to climate shocks and protect the soil (Kassam *et al.*, 2017). These three principles are: 1) minimum mechanical soil disturbance; 2) maintenance of soil cover; and 3) crop rotation, usually with legumes (Kassam *et al.*, 2017). CA practices can increase food security through consumption of own-grown produce and may

boost farm production and income by improving productivity. CA is currently replacing both traditional and modern plough-and hoe-based agriculture at an annual rate of some 10 million ha globally, accounting for more than 157 million ha, which was about 11 percent of the world's cropland as of 2013 (Kassam *et al*., 2017).

A total of 21 000 lead farmers were to be enrolled in the CASU project, each of whom would be responsible to conduct demonstrations for 10-15 follow farmers. The lead farmers were provided with e-vouchers for the purchase of bicycles to facilitate movement and for access to CA inputs, equipment and mechanization services. The project facilitated the involvement of suppliers to provide inputs through the e-voucher system. The CA-relevant products were registered and channelled through selected agrodealers in various locations for the follow farmers to be able to access these products. For the 2016 to 2017 agricultural season the project provided selected lead farmers with inputs falling under three voucher categories: input voucher for legume seeds, targeted mostly to female farmers; transport voucher for bicycles, targeted to farmers with more than one ha of land; credit voucher for inputs for seed production, targeted to farmers producing legume seed.

Box 1: Conservation agriculture (CA)

Conservation Agriculture (CA) is defined as a set of farming practices that reduces or eliminates soil tillage, maintains a permanent organic soil cover consisting of a growing crop or dead mulch and diversifies crop species grown in sequence or in association. CA aims to reduce soil degradation through these practices, which minimize the alteration of soil composition and structure, unlike conventional forms of agriculture which regularly use ploughs to enable a deep tilling of the soil. The alternative to tillage proposed by CA consists of sowing the seeds or planting the crops directly in the untilled soil to maintain soil structure and porosity. Moreover, the function of the permanent organic cover is to protect the soil from sun, rain and wind so that water and nutrients are conserved. Planting crops in association, sequence or rotation contributes to greater crop nutrition. Since different crops root at different soil depths, they are capable of exploring different soil layers for nutrients (FAO, 2015). The use of crop residue and zero tillage allows the accumulation of carbon in the soil, while plough-based tillage releases it into the atmosphere. Consequently, CA is referred to as being climate-smart and is included among climate-smart agriculture options (Kassam *et al*., 2017).

In some areas, HGSF beneficiary farmers could also benefit from productive support through the CASU programme; conversely, CASU beneficiaries could benefit from the market access offered by HGSF. Programme implementers on both sides tried to coordinate and target the same areas, down

to block level, to trigger the envisaged complementarities between the two programmes.[4] According to CASU's project document, one of the aims of the project was to establish partnerships with aggregators and other partners, such as WFP, for collection of marketable surplus commodities, particularly of legumes. CASU aimed at facilitating access to legume seeds in order to expand legume cultivation.[5] The market access offered through the P4P programme offers an opportunity to develop the agricultural value chain. On the supply side, local smallholder farmers can benefit from such an initiative by having a secure market to sell to. In addition, by providing a market for legumes – one of the deliverables of the CA project – the incentive provided by the P4P programme purchasing locally for the HGSF school meals and other uses creates an incentive for the adoption of these practices. At the same time, smallholder farmers are more likely to meet the extra demand from the P4P programme when also benefiting from CASU's productive support. However, the synergies between WFP's local purchases and FAO's CASU envisaged at the programmatic stage were only partly followed by concrete coordination at the implementation stage. Overlap of the two programmes at the household level was not systematically pursued. As a result, some but not all farmers who benefit from HGSF also benefit from CASU in a given farming block.

Despite the partial overlap between the two programmes, this setup creates an opportunity to begin to quantify the impacts of the combination of these programmes and to shed light on an area of increasing interest, which is the coherence between social protection and agricultural interventions.

The impact evaluation was designed with multiple treatment arms to capture the complementarities between the HGSF programme and an agricultural support intervention (CASU). This implies the need to identify four treatment arms: one with farm households that benefit from both HGSF and CASU; one with households that benefit only from HGSF; one with households that benefit only from CASU; and a control arm with farm households that benefit from neither of these programmes. From an evaluation point of view, the complementarities between CASU and the local purchases through P4P for HGSF are easy to detect. We expect adoption of CA techniques to be more likely if a market for the produce is guaranteed and, vice versa, an intervention providing market access should be more likely to meet its quantitative targets of purchased produce when the beneficiary farmers also receive specific agricultural training such as CA.

In this setup, it is impossible to separate out the effects of the single components of the HGSF – i.e. the market access and the school meals *per se*. For this to be possible we would have needed an extra arm, with households that benefit only from school meals but not from local purchases. Therefore, when comparing outcomes of farm households selected from areas under both P4P's local purchases and school meals with the outcomes of similar households coming from control areas that benefit from neither, we are capturing the effects of both programme components – i.e. of the HGSF programme as a whole. However, one component may have a greater impact on specific

[4] From an administrative point of view, the Zambian territory is organized into provinces that are further divided into districts. In each district, urban communities or towns are called *bomas,* while the rural areas of the district are organized in farming blocks that in turn include several agricultural camps. Each agricultural camp includes several villages.

[5] The most important part of CASU is the training on CA practices. The legume seeds vouchers went to the lead farmers for the demonstrations and may have had a greater influence on legume production. That said, however, CA practices can be applied to any crop. The legume production was also meant to be part of the cooperation with HGSF, which would have bought legumes from CASU farmers.

outcomes and only indirect second order effects on others. Public food procurement amounts to providing guaranteed sales of produce and represents more predictable demand, with expected impacts on productive choices and income and food security. Higher income may have indirect second order effects on food security and schooling indicators. One meal a day provided to schoolchildren is expected to have positive impacts on educational and food security outcomes and may only indirectly affect farm outcomes (see Section 2 on the theory of change).

2. Theory of change

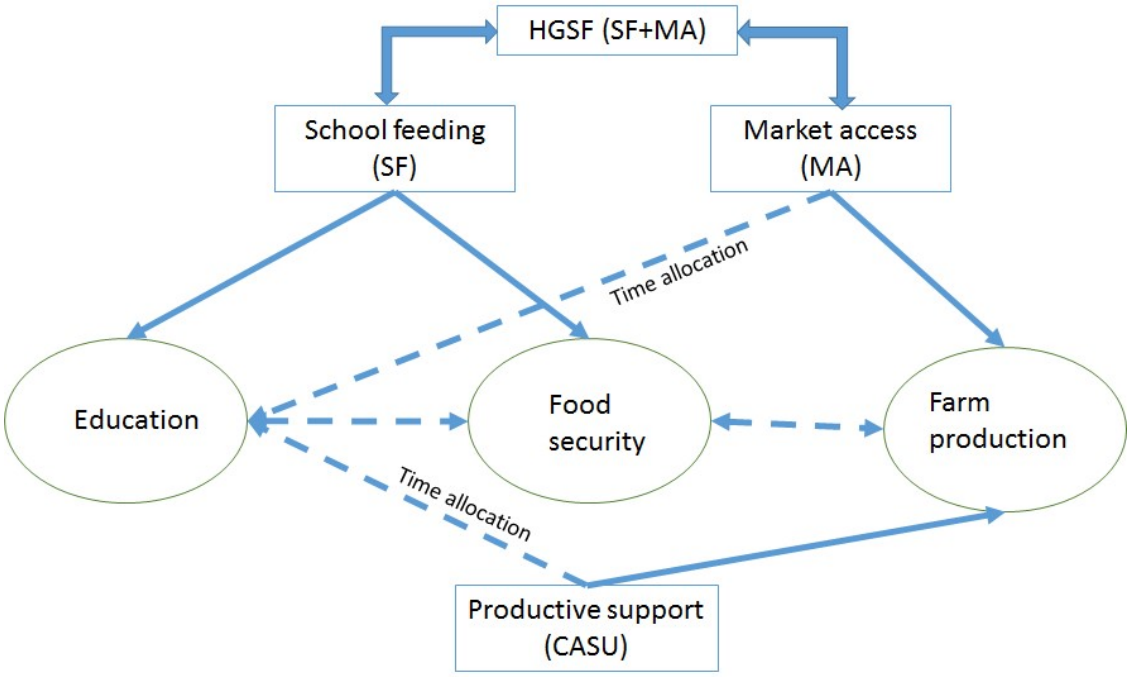
In this section we describe the pathways through which HGSF and CASU exert their influence on farm production, food security and educational outcomes, both separately and jointly by complementing each other. Figure 2 illustrates the theory of change by denoting programmes as rectangles, outcomes as ellipsoids, direct effects as continuous arrows and indirect or second order effects as dashed arrows.

School meals programmes affect educational outcomes directly by increasing enrolment, attendance and completion. Children may not participate in schooling for reasons related to the trade-off between the costs and benefits of schooling. Costs are not only direct, such as school fees, but also include the opportunity cost of sending a child to school, in terms of forgoing the benefits of any work that the child could be doing instead of attending school. The provision of school meals gives an incentive for households to send children to school through a transfer (the daily meal) that is intended to help offset the financial and opportunity costs of schooling. SF may also have an incentive effect on pupils actually wanting to go to school to receive food rather than staying at home and missing out.[6] Learning is directly affected by increased attendance, but also indirectly through better feeding. In fact, higher food security through SF can improve concentration.

SF interventions can potentially have an impact on the food security status of schoolchildren and other household members. These impacts depend on the extent of food substitution effects within the household and the use of the energy intake by the child and other family members. The school meal can be shared by children with other household members or can substitute (at least partly) for food normally consumed in the home. Moreover, school meals can affect intrahousehold distribution of food, in favour of household members who do not go to school.

[6] In Zambia the HGSF programme is mainly in remote districts, which are also food-insecure, with high poverty levels and low education indicators. In many of these areas, the school meals, especially in lean seasons, are the only meals that the children have in a day. So the issue of school meals being an incentive for children coming from poor households is valid.

Figure 2: Theory of change



Note: The continuous arrows indicate a direct effect, while the dashed arrows indicate an indirect influence. The double-headed arrows indicate a mutual influence.

On the farmers' side, purchases through the HGSF programme for the school meals are designed to stimulate farm production, as they provide stable market access by purchasing food from smallholder farmers. In recent years, there has been a consensus among development practitioners and academics that improving market access for smallholders will lead to improvement in income and food security (Lanjouw and Murgai, 2008; Wiggins and Keat, 2013). However, the reality of the African agricultural context is characterized by several barriers to market access, such as information asymmetries and low bargaining power. First, smallholder farmers, who are mostly in rural areas, often do not have access to information regarding prices in urban areas; they mostly sell at unfavourable farm gate prices to local traders. Second, most production systems in Africa perform on a small scale and hence farmers acting individually are not able to participate in new markets. In addition, because individual farmers offer only small quantities of produce for sale, they have little bargaining power with traders and will most often accept almost any price offered. Information asymmetry is the main reason why markets perform poorly and why transaction costs are so high. Market-oriented production systems must be built upon the establishment of efficient systems that keep transaction costs low, minimize risk and extend information to all players, and that do not either exclude or operate contrary to the interests of small and poor farmers.

More systematically, purchases through the HGSF programme can have three types of effects on the farmers' side: output effects; distributional effects; and stabilization effects. The extra demand can increase production by the beneficiary farmers. Moreover, since the intervention is targeted at smallholders instead of larger farmers, it can also have distributional effects in the community.

Finally, being a stable and predictable source of income, it may stabilize the farmers' expectations and their risk-taking behaviour.

The HGSF programme introduces additional demand for pulses in the community, which leads to a rightward shift of the demand curve for pulses. The likely effects of this shift include an increase in both production and prices, and hence of farm income for the farm households supplying HGSF. The amount by which production and prices will increase depends on the size of the demand shift and the elasticity of supply of pulses. The smaller the reduction in food consumption at home because of school feeding (substitution effect), the greater the shift in demand coming from HGSF will be. The shift will also have a larger impact on local producers if imports from outside the district do not respond to the extra demand. The supply elasticity of pulses depends on yield risk, market failures and rigidity of fixed factors. High income risk and missing markets are likely to be present in the areas of intervention, thus reducing the size of supply elasticity.

In addition, while farmers may be able to adjust the amount of variable inputs, they may not be able to change the amount of fixed inputs in the short run (equipment, land and livestock). Hence, if farmers provide any additional food demanded by using current inputs more intensively and by quickly changing the use of fixed inputs (large supply elasticity) then HGSF would have a large impact on output and a negligible impact on prices. If farmers are not able to provide the additional food demanded by HGSF (small supply elasticity) then most of the effect of HGSF goes into prices with little impact on output. Based on this theoretical model, the programme will have a positive impact on farmers' incomes via an increase in prices and food quantities produced.[7] This increase in farm income may in turn indirectly affect food security and educational outcomes. Greater income may allow the household to buy more food and afford school expenses and transportation costs, but the extra effort required to produce the extra income may also be detrimental to food security and schooling.

The programme also has a distributional impact, as it directs the extra demand to small farmers, leaving out larger farmers. Finally, by offering a stable demand and price the programme stabilizes income for small farmers, thus potentially reducing risk. This implies a reduction in the use of inefficient coping strategies, (such as lower-yielding crops and precautionary savings) and an increase in productive investments and in the adoption of new technologies.

CASU, in turn, consists of training on CA and distribution of agriculture inputs. From the first adoption to its complete and stabilized use, CA development can be summarized as follows. First, no increase in farm output is foreseen at the initial phase; reductions of production costs will occur through decreases in labour, time, draught animal use or motorized power. An increase in agrochemical use, especially to control weeds, might be required. Second, an increase in yields and consequent increase in net farm income is expected after improvement of soil fertility. Third, the diversification of crops leads to increased and more stable yields and finally, production and productivity stabilize.

Therefore, the CASU programme is expected to increase farmers' incomes by boosting yields and production through greater and better input utilization and new technology adoption. Furthermore,

[7] The impact on consumers is less obvious. Depending on the size of the increase in prices, some households may have their welfare reduced as a result of the intervention.

it is also likely to have a positive impact on food security by increasing food consumption for the beneficiary farm households both through higher incomes and from their own production. There is evidence that agricultural interventions can improve the diversity of food produced, which can contribute to better diets (Dewbre *et al*., 2015 for Lesotho; Escobal and Ponce, 2015 for Colombia). Further, considering that CA practices are knowledge-intensive, CASU may also increase human capital, by means of training group members in new skills. The indirect effects on food security and schooling outcomes of productive support through CASU are similar to those illustrated above for HGSF's market access.

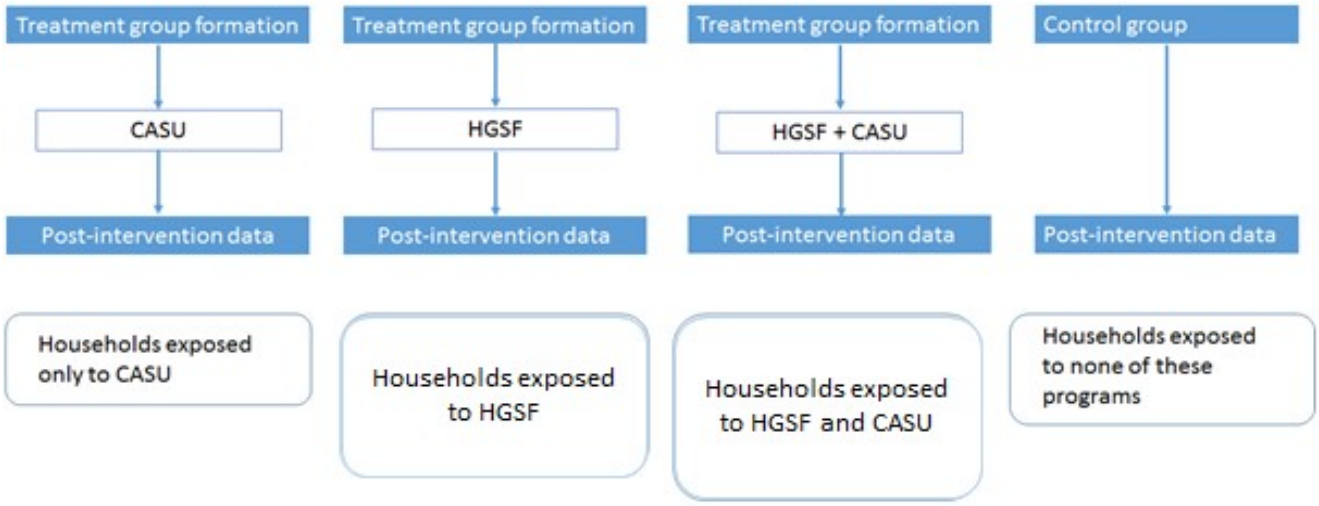
As shown in Gavrilovic *et al.* (2016), coordinated agricultural and social protection interventions such as CASU and HGSF can complement and mutually reinforce each other. On the one hand, secure market access through the HGSF programme may increase incentives for farmers to produce more and more efficiently and make them more prone to adopting the production technologies taught through the CASU programme. On the other hand, farmers with access to CASU training and inputs would be better suited to reap the benefits from the increased market access than similar farmers who do not benefit from CASU. Moreover, the effects on farm production, food security and education from the joint implementation may be greater than the sum of the effects of each programme applied in isolation (synergic effects).

3. Research design and evaluation sample

The goal of an econometric impact evaluation is to quantify the observed impacts of an intervention using a methodology that allows attribution of such impact to the intervention. Since the HGSF and CASU programmes were already underway and no expansions in new areas were foreseen in the near future, a randomized control trial evaluation was not feasible in our case. In such circumstances, a non-experimental study is the only viable option.

In true experimental settings all three of the following features are present: manipulation of the treatment, randomization and control of the experiment. Quasi-experimental designs share one or more characteristics of true experiments. The HGSF and CASU evaluation represents a quasi-experiment, as only the manipulation of treatment is present. According to an established taxonomy in research methodology, the current design represents an example of an "After only Non-equivalent Control Group" type of quasi-experiment. In this design no baseline (pre-intervention) data are collected; therefore the treatment arms can only be compared post-intervention. This is illustrated graphically in Figure 3.

Figure 3: Scheme of an "After only Non-equivalent Control Group" design



There are four treatment arms in this combined impact evaluation study: HGSF-only arm: households benefiting from HGSF but not from CASU; CASU-only arm: households benefiting from CASU but not from HGSF; HGSF+CASU arm: households benefiting from both HGSF and CASU; Control arm: households benefiting neither from neither HGSF nor CASU.

Given the geographical spread of the programmes and considering the need to contain the data collection area in order to minimize costs, it was decided to concentrate the survey in a number of districts in the south and northeast of the country. The geographical coverage of the sample study is as follows: HGSF-only arm: Luwingu, Kawambwa; CASU-only arm: Chongwe, Chibombo; HGSF+CASU arm: Katete; Control arm: Kafue, Kasempa, Mporokoso. Figure 9 in the Appendix shows a map of the districts covered by the study for each treatment arm.

The HGSF-only treatment arm is composed of households who sold to cooperatives selected by P4P and lived in districts where school meals are provided under the HGSF programme. The CASU-only arm is composed of households that received support in CA as the sole intervention. The HGSF+CASU intervention arm is operationally defined as households that received support in CA and lived in farming blocks covered by the HGSF both in terms of public food procurement and school meals. The control group is composed partly of households that were eligible to benefit from public food procurement from HGSF but were not covered by the intervention and partly of households that were eligible for CASU but did not take part in the programme. With regard to the HGSF-eligible controls, these were households not taking part in the programme but eligible for HGSF's local purchases component on the basis of being members of cooperatives in control districts. The CASU-eligible control households were selected from control districts on the basis of having at least half a hectare of land.[8,9] Table 1 shows the sample size for each treatment arm and the geographical distribution in terms of districts.

Table 1: Actual sample size by treatment arm and district

		DISTRICT (Count)								
		Chibombo	Chongwe	Kawambwa	Luwingu	Katete	Kafue	Kasempa	Mporokoso	TOTAL
HOUSEHOLD TYPE	CASU Only	404	363	0	0	0	0	0	0	767
	HGSF Only	0	0	612	200	0	0	0	0	812
	HGSF + CASU	0	0	0	0	467	0	0	0	467
	Control HGSF eligible	0	0	0	0	0	275	312	238	825
	Control CASU eligible	0	0	0	0	0	186	159	154	499
	Ineligible	13	5	57	112	0	38	10	34	269
	TOTAL	417	368	669	312	467	499	481	426	**3,639**

For the CASU-only arm, the full list of beneficiaries in the two selected districts was obtained from the programme implementers in FAO Zambia. The final sample was selected by two-stage cluster sampling. The primary sampling unit was the agricultural camp and the secondary sampling unit was the household. In the HGSF-only arm, all members of all cooperatives that had benefited from the P4P purchasing programme in the districts of Kawambwa and Luwingu were interviewed. For the

[8] The selection criteria for lead and follow farmers are reported in the Appendix. The main eligibility criterion for CASU follower farmers was having at least half a hectare of land. This is the working definition of CASU eligibility criterion that was used for selecting the sample during the household survey.

[9] The survey also collected data on ineligible households but they will not be considered in the present study. The ineligible households were selected from all districts and the criteria were not being members of a cooperative and owning or renting land of strictly less than half a hectare.

HGSF+CASU arm, two specific blocks where both HGSF and CASU were operating were identified in the district of Katete. The full list of CASU beneficiaries in those blocks was obtained from the programme implementers. The number of enrolled beneficiaries in these two blocks was lower than the target sample size; therefore, the final sample was created by all beneficiary households in the list and no random sampling was applied. In the three control districts the full list of cooperatives was obtained from district authorities. For the HGSF-eligible control households the primary sampling units were the cooperatives. These were selected by simple random sampling from the full list of cooperatives. The data collection firm was provided with the contact details of the cooperative chairperson, who then facilitated the interviews with the cooperative members. For selection of the CASU-eligible control households the data collection firm used the list of enumeration areas (EAs) provided by Zambia's Central Statistical Office. EAs were used as the primary sampling unit. In the selected EAs, the data collection firm interviewed households with at least half a hectare of land.

A number of caveats must be mentioned, which stem from several difficulties that the study designers faced in accessing the necessary auxiliary information to implement the survey. The first caveat is related to the type of programme exposure received by the households in the HGSF-only arm. As far as the evaluation of the HGSF as a standalone programme is concerned, ideally we would have preferred to have a group of farm households that benefit from a market access intervention that purchases only or mostly for the supply of the school meals offered by the programme. This would allow the evaluation of the impacts of HGSF as one single programme that buys produce from local farmers and delivers school meals to the children from the same local community. However, there are several circumstances that do not allow this approach. First, while the school meals are offered in all primary schools in a district, the P4P purchases benefit a limited number of farmers and are concentrated in much more limited areas inside the district – usually a block or even a camp. Second, there are only a few districts in Zambia where the P4P purchases go mostly or exclusively to meet the schools' demand for meals. In most districts, the produce purchased by P4P from the aggregators goes only in small part to supplying the school meals, with the rest being earmarked for other types of social protection. Third, farm households do not sell their produce directly to P4P but to aggregators – i.e. cooperatives or agrodealers. The latter type of aggregator buys crops from any local farmer, for many purposes, and does not necessarily keep records of transactions and counterparts. Therefore, when P4P buys from an agrodealer it is virtually impossible to identify the beneficiary farmers, since an undefined area around the agrodealer may be benefiting. Cooperatives, however, buy mainly from their own members, mainly for the amount negotiated with P4P, and they keep records of their members. This makes it easy to pin down the beneficiary farmers and to establish a direct link to a single farm household. To include an area in the survey, two criteria would have to be satisfied: P4P buys only or mainly for the HGSF school meals and not for other purposes; P4P buys only or mainly from cooperatives and not from other aggregators. The first criterion makes it possible to establish a direct link between the beneficiary cooperatives and the additional demand coming from the school meals for the HGSF programme. The second criterion makes it possible to trace back to the farmers who produced and sold their produce to the cooperative. Unfortunately, no district satisfies these criteria at the same time. In districts where P4P buys exclusively to satisfy the HGSF demand, the aggregators are not cooperatives and in all districts where P4P purchases only through cooperatives, the purchases are never dedicated completely or mainly to HGSF. This led us to focus on districts where P4P purchased through cooperatives regardless of whether the purchases

went for the HGSF programme or for other purposes. This implied that we were evaluating public food procurement as a whole – not just the part dedicated to meeting the school meal demand – along with the SF part of the HGSF. In other words, any impact, be it on farming, food security or educational outcomes, cannot be attributed to the extra demand coming from the school meals *per se*, but is the result of the total P4P purchases.

Second, the HGSF+CASU arm is composed of households that received support in CA and live in farming blocks covered by the HGSF both in terms of public food procurement and school meals. Exposure to HGSF is certain for the school meals part, since all households in the area are eligible for it, but not for the public food procurement part. The study designers could get access to the list of CASU beneficiaries in those blocks but not to the list of P4P beneficiaries, so it was impossible to draft a list of households benefiting from both programmes at the same time. We chose to sample from the full list of CASU beneficiaries. In this way, we were sure that the households of the combined group were exposed to CASU. Knowledge that both programmes were operating in the same block, which is a small unit, and the fact that the CASU list of beneficiaries included a relevant share of the block's population, increased the odds of these households also being exposed to HGSF's local purchases.

The study also included a community survey, implemented by asking selected "Key Informants" with adequate information about a specific community (camp or block) where a programme of interest was being implemented and data were being collected. Key informants were individuals such a village headman, community group leader, school head teacher, and so forth. Ten questionnaires per district were planned to be collected for a total of 80. The data collection firm managed to collect a total of 72 community questionnaires.

Actual data collection commenced in the Chibombo district on 6 October 2017 and continued throughout the month. During this first period the interviews were completed for almost 75 percent of the sample, leaving out only the HGSF+CASU treatment arm. Data collection was interrupted during November and December because rainfalls made some areas inaccessible. The last part was collected in early January 2018 over a two-week period.

4. Data analysis methodology

When randomization is not used, treated and control groups are often formed by deliberate choices made by economic agents (farmers, individuals, households), reflecting either the personal preferences of the subjects themselves or the view of some services/goods providers that certain agents would benefit the most from the treatment. Deliberate selection of this sort can lead to substantial biases. Pre-treatment differences or selection biases are of two kinds: those that have been accurately measured – called overt biases – and those that have not been measured but are suspected to exist – called hidden biases. Post-intervention differences in an outcome measure may reflect partly the effect of treatment and partly the effect of measured or unmeasured pre-intervention differences in the treatment arms. Removing overt (measured) biases and addressing uncertainty about hidden biases are central issues in non-experimental studies.

In an "After only Non-equivalent Control Group", observed pre-treatment biases are eliminated through statistical modelling in the design and in the analysis stage of the study. We use inverse probability weighted (IPW) to remove observable pre-treatment differences between the treated subjects and the controls. This method approximates an experiment as it ensures only the elimination of observed pre-intervention differences among the treatment arms (balanced covariates) but relies on the assumption that the groups are otherwise equivalent, on average, in terms of unobserved or hidden characteristics.

In this setting the estimation of causal effects is slightly different from the standard binary comparison whereby the average outcome of the treated group is compared with the average outcome of the comparison group. Here we have three treatment groups and the comparison group of those not exposed to either of the two treatments. The statistical model that is more useful in this setting is one with a multivalued treatment. The treatment t_i takes integer values in a set J=$\{0,1,..j..K\}$. In our case, K=3 and j=0 for all households that belong to the comparison group. Let $D_j(t_i)$ be a dummy indicator for individual i belonging to treatment arm j – i.e. $D_j(t_i) = 1$ if $t_i = j$ and 0 otherwise. We can define the causal parameter of interest as the average treatment effect on the treated for a particular treatment group t – i.e. $ATT(t) = E[Y_i(j) - Y_i(0)|t_i = j]$. Estimation of the causal parameters of interest is based on the following equation (Uysal, 2013)

$$y_i = \sum_{t=0}^{K} \alpha_{0t} D_t(t_i) + \sum_{t=0}^{K} D_t(t_i)(X_i - \bar{X})\alpha_{1t} + \varepsilon_i \quad (1)$$

where ε_i is a mean zero error term. The constant term is omitted from equation (1) so that $ATT(j)$ is identified as $\alpha_{0j} - \alpha_{00}$. So, for instance, the impact of the CASU-only programme on a given outcome variable is estimated as the difference between the conditional post-intervention average outcome for the CASU-only group and the conditional post-intervention average outcome for the control group.

As mentioned earlier, in the study design of this evaluation households were not randomly assigned across the different treatment arms $t \in$ J. In order for *ATT*(j) to be consistently estimated through

equation (1), unobserved factors should be equally distributed across the treatment arms, on average, and conditional on observed characteristics.[10] Formally, this can be expressed as $E[Y_i(j)|X_i] = E[Y_i(j)|D_j(t_i) = 1, X_i] = E[Y_i|D_j(t_i) = 1, X_i] = E[Y_i|t_i = j, X_i]$, $j \in J$. Therefore, after accounting for observable characteristics, the difference in average outcome between any two groups depends only on the exposure to a given treatment. This assumption implies that household characteristics are equally distributed across the control and the various levels of treatment. To make the validity of the conditional mean independence assumption[11] more plausible, we apply an IPW regressionapproach, which aims at balancing the distribution of covariates across all treatment levels. We use stabilized weights given by $Sw = \frac{P(t)}{P(t|X)}$ where $P(t|X)$ is the generalized propensity score (GPS) and $P(t)$ is the unconditional density of treatment. The GPS is the conditional probability of receiving a certain treatment level and is estimated through a multinomial logit specification – i.e. $P(t|X) = \frac{P(t_i=j|X)}{P(t_i=l|X)} = X_i\beta$ – while the unconditional density is estimated through the simple frequencies in each treatment group. Our final estimating equation is based on a Weighted Least Squares version of equation (1). The resulting IPW regression is doubly robust in the sense that if at least one of the equations – the outcome or the GPS – is correctly specified in terms of functional form and conditioning variables, then the causal effect is consistently estimated.

Assessing whether the balancing property is verified is a fundamental diagnostic check that also allows us to informally gauge the validity of our identifying assumption. Here we test it by assuring that the observed characteristics are (mean) independent from treatment status (Prifti *et al*., 2018).

We start data analysis by verifying the validity of our methodology for creating observationally similar groups of households across the four treatment arms. To do so we first show averages of some selected household characteristics in the raw sample.

[10] For the combined group, we identify the Intention to treat (ITT) parameter, given that we don't know exactly how many are actually exposed to the HGSF programme.

[11] The Conditional Mean Independence Assumption is an identifying assumption according to which the counterfactual outcomes are the same regardless of the treatment status, once we condition on observed characteristics.

Table 2: Sample characteristics by treatment arm in the original data

	CASU	HGSF	HGSF+CASU	Control	p(F)
HH size	6.099	4.586	5.874	4.733	0.000***
Female-headed (%)	0.224	0.143	0.184	0.187	0.001***
Single-headed (%)	0.245	0.141	0.152	0.203	0.000***
Age of head	34.369	32.457	34.985	35.128	0.088*
Education of head (years)	7.220	6.219	5.600	6.835	0.000***
# members age 0-5	2.554	1.265	2.158	1.263	0.000***
# members age 6-14	1.068	0.820	0.786	0.887	0.000***
# members age 15-65	2.288	2.396	2.803	2.441	0.000***
# members age >65	0.149	0.087	0.099	0.122	0.006***
Labour-constrained	3.540	2.463	3.130	2.494	0.000***
Literacy rate (%)	0.611	0.577	0.542	0.611	0.000***
Operated land (ha)	5.835	3.779	5.122	3.163	0.000***
TLU owned 2 years ago (#)	2.639	0.567	6.594	1.177	0.041*

Note: * 0.1 ** 0.05 *** 0.01. The last column has the p value of F-test for multiple mean comparisons.

Each of the first four columns in Table 2 shows the average for the specific treatment arm. For instance, households have six members on average in the CASU-only treatment arm and four and a half members on average in the HGSF-only arm. The last column shows the p value of an F-test for multiple mean comparisons. All observed characteristics are unequally distributed across the four treatment arms. If these differences are not properly taken into account, they may confound the impacts of the two programmes and of their combination. By reweighting the data we manage to reduce some of these differences and push the four arms closer to each other. Table 3 shows sample averages by treatment arm after reweighting. The last column shows that the number of statistically significant differences has been reduced considerably.

Table 3: Sample characteristics by treatment arm in the reweighted data

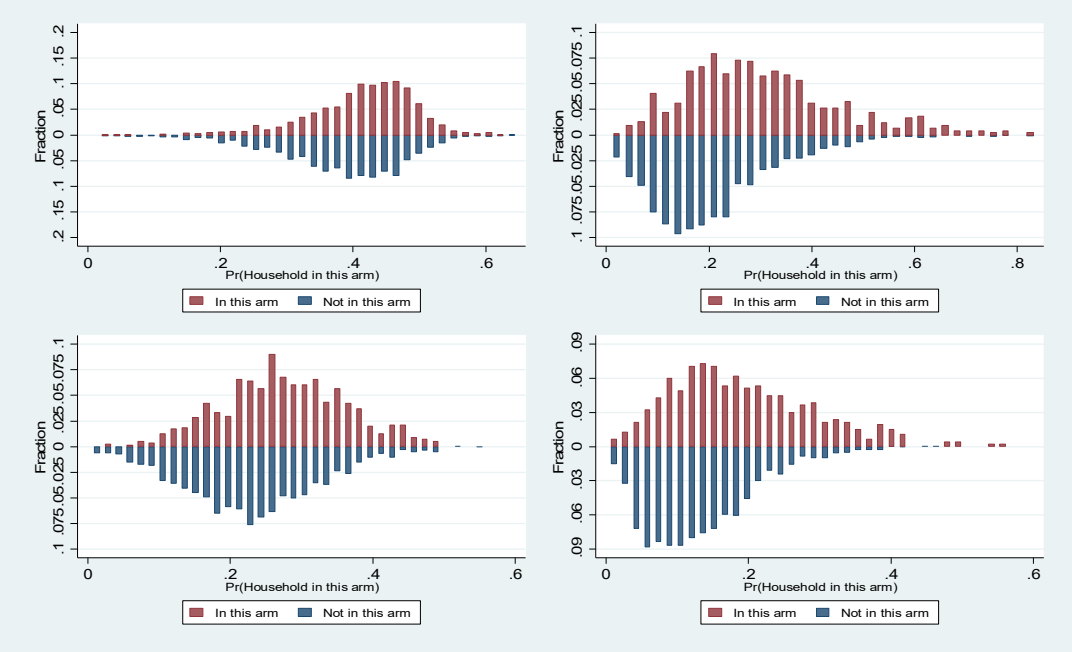
	CASU	HGSF	HGSF+CASU	Control	p(F)
HH size	5.191	5.186	4.984	5.391	0.009***
Female-headed (%)	0.168	0.175	0.199	0.177	0.571
Single-headed (%)	0.177	0.179	0.243	0.184	0.013*
Age of head	33.873	34.179	35.437	33.715	0.604
Education of head (years)	6.635	6.652	7.314	6.616	0.009***
# members age 0-5	1.720	1.759	1.532	1.972	0.045*
# members age 6-14	0.888	0.895	0.882	0.878	0.990
# members age 15-65	2.419	2.391	2.417	2.405	0.994
# members age >65	0.126	0.115	0.133	0.115	0.767
Labour-constrained	2.888	2.895	2.583	2.915	0.291
Literacy rate (%)	0.592	0.588	0.621	0.590	0.211
Operated land (ha)	5.366	4.061	5.229	3.310	0.002***
TLU owned 2 years ago (#)	2.275	0.573	7.326	1.558	0.044*

Note: * 0.1 ** 0.05 *** 0.01. The last column has the p value of F-test for multiple mean comparisons.

The ability of the reweighting method to level out observed differences depends largely on the underlying similarity of the sample across treatment arms. From a statistical point of view, similarity across treatment arms can be measured through the propensity score – i.e. the probability of a household to belong to a given treatment arm. We plot the distribution of the propensity score in a given arm against the distribution of the propensity score in the rest of the sample. If the two distributions are similar and overlap, it implies that for a household with given observed characteristics in a given arm we can find observationally similar households in the other arms, which in turn reassures the analyst that outcomes are being compared across similar groups and that effects can be attributed to the treatment. The top left graph in Figure 4 shows in red bars the distribution of the probability of belonging to the CASU-only arm for households actually receiving the CASU-only treatment. The blue bars show the distribution of the probability of belonging to the CASU-only arm for the rest of the households – i.e. those of the remaining arms. These households have a similar distribution of the probability of belonging to the CASU-only arm as those who actually belong there. The same conclusion can be reached for the other households. Therefore, we rest

assured that the reweighted regression is comparing households that differ as little as possible in characteristics other than participation in a given treatment arm.

Figure 4: Propensity score overlap



Note: Red bars indicate the conditional probability for a household of belonging to a given group given that they belong to that group (CASU top left, HGSF top right, HGSF+CASU bottom left, control bottom right) while the blue bars indicate the conditional probability of belonging to that group for the rest of households.

5. Results

5.1. Farm production and other income-generating activities

This section shows the average impacts of each programme in isolation and of their combined implementation on farm production, non-farm sources of income and related outcomes.

Crop production

Table 4 shows the impacts of the programmes on the spread of each crop in the evaluation sample – i.e. on the share of farmers that grow a given crop. The first four columns show the post-intervention average for each crop, columns five and six show the impact of the CASU and the HGSF programmes, respectively, when implemented alone, while column seven shows the impact of the combined implementation of two programmes. Maize is the most widely grown crop in the CASU, combined CASU+HGSF and control groups. In the HGSF group, beans are the most widely grown crop, with 89.7 percent of the households growing some, while maize is only the second most grown crop, as 79.2 percent of farmers grow it. Other crops that stand out are groundnuts, which are grown by 18-54 percent of households in the sample. Soybeans are grown by 54 percent of the combined group but show a low spread – between 1 and 14.6 percent – in the other groups. Cowpeas are grown by 15.5 percent of CASU farmers but have low diffusion – between 1 and 5 percent – in the rest of the arms.

The CASU led to an increase of 5.6 percentage points in the share of farmers cultivating maize. In relative terms, the number of maize farmers grew by almost 6 percent compared with the control group, which represents the counterfactual situation for our treatment groups – i.e. what would have been observed in absence of the programmes. Other noticeable effects are on groundnuts, cowpeas and sweet potatoes, for which the share of growers increased by 1.6 times, 15 times and 2.4 times, respectively. In the CASU arm, the wider spread of these crops is compensated for by a diminished diffusion of beans, cassava, millet and sorghum among farmers. The number of beans growers is reduced by 64 percent. In the HGSF arm, the pattern of the various crop growers is reversed. The HGSF programme leads to an increase of 1.5 times the number of beans growers and to a 15 percent reduction of maize growers. There is also a noticeable increase in the spread of groundnut and of cassava among HGSF beneficiaries. Their diffusion is increased by 1.5 and 3 times, respectively, compared with the control group, which emulates the pre-intervention situation in areas under HGSF. In the combined arm, the impacts are similar in sign and magnitude to those observed for the CASU-only arm for virtually all crops.

Table 4: Share of households producing crops

	CASU	HGSF	Both	Control	CASUvsCtrl	HGSFvsCtrl	BothvsCtrl
Beans	0.170	0.897	0.129	0.339	-0.217***	0.527***	-0.254***
	(0.014)	(0.011)	(0.016)	(0.014)	(0.024)	(0.025)	(0.029)
Cowpeas	0.155	0.010	0.052	0.008	0.121***	0.001	0.031**
	(0.013)	(0.004)	(0.010)	(0.003)	(0.012)	(0.013)	(0.015)
Maize	0.993	0.792	0.978	0.933	0.056***	-0.138***	0.046**
	(0.003)	(0.015)	(0.007)	(0.007)	(0.016)	(0.017)	(0.019)
Cassava	0.012	0.326	0.013	0.079	-0.078***	0.245***	-0.069***
	(0.004)	(0.018)	(0.005)	(0.008)	(0.018)	(0.019)	(0.022)
Groundnuts	0.491	0.430	0.547	0.180	0.292***	0.263***	0.368***
	(0.018)	(0.019)	(0.023)	(0.011)	(0.028)	(0.030)	(0.035)
Cashew nuts	0.000	0.000	0.000	0.001	-0.001	-0.001	-0.001
	(.)	(.)	(.)	(0.001)	(0.001)	(0.001)	(0.001)
Millet	0.001	0.122	0.000	0.067	-0.071***	0.046***	-0.073***
	(0.001)	(0.013)	(.)	(0.007)	(0.014)	(0.015)	(0.017)
Seed cotton	0.071	0.000	0.142	0.006	0.062***	-0.010	0.157***
	(0.009)	(.)	(0.016)	(0.002)	(0.011)	(0.012)	(0.013)
Sorghum	0.005	0.000	0.006	0.061	-0.056***	-0.058***	-0.047***
	(0.003)	(.)	(0.004)	(0.007)	(0.010)	(0.010)	(0.012)
Sugar cane	0.013	0.004	0.004	0.003	-0.003	-0.002	-0.001
	(0.004)	(0.003)	(0.003)	(0.002)	(0.005)	(0.005)	(0.006)
Rice	0.000	0.000	0.009	0.001	-0.001	-0.001	0.005*
	(.)	(.)	(0.004)	(0.001)	(0.002)	(0.003)	(0.003)
Soybeans	0.146	0.012	0.524	0.030	0.115***	-0.028	0.518***
	(0.013)	(0.004)	(0.023)	(0.005)	(0.017)	(0.019)	(0.021)
Tobacco	0.000	0.000	0.011	0.001	-0.001	-0.001	0.009***
	(.)	(.)	(0.005)	(0.001)	(0.003)	(0.003)	(0.003)
Sunflower	0.063	0.001	0.381	0.003	0.045***	-0.005	0.382***
	(0.009)	(0.001)	(0.023)	(0.002)	(0.014)	(0.015)	(0.017)
Tea	0.000	0.001	0.000	0.000	0.000	0.002*	0.000
	(.)	(0.001)	(.)	(.)	(0.001)	(0.001)	(0.001)
Coffee	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	(.)	(.)	(.)	(.)	(.)	(.)	(.)
Flowers	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	(.)	(.)	(.)	(.)	(.)	(.)	(.)
Potatoes	0.005	0.009	0.000	0.007	-0.001	0.003	-0.005
	(0.003)	(0.004)	(.)	(0.002)	(0.004)	(0.005)	(0.005)
Sweet potatoes	0.245	0.065	0.101	0.059	0.144***	0.003	0.064***
	(0.016)	(0.009)	(0.014)	(0.007)	(0.019)	(0.020)	(0.023)
Other	0.038	0.003	0.015	0.027	0.009	-0.021**	-0.013
	(0.007)	(0.002)	(0.006)	(0.005)	(0.009)	(0.010)	(0.011)

Note: * 0.1 ** 0.05 ***0.01. Columns 1 to 4 show the post-treatment unconditional averages of the outcome variables. Columns 5 to 7 show, respectively, the average effect of the CASU alone, the HGSF alone and of the combined treatments.

Table 5 has the same structure as Table 4 and shows the harvested quantities in kilograms during 2017 for all identified crops. In all treatment arms, maize, beans and groundnuts are the most important crops. Each household harvested between 1.3 and 3.4 tonnes of maize in the last agricultural season. The average amount of groundnuts harvested varies between 63 and 329 kg, while beans production is especially high in the HGSF arm, at 877 kg, because of the demand coming from the P4P, but varies between 32 and 103 kg for the other arms. In terms of impacts, the CASU is associated with an increase of 68 percent in the production of maize. The production of groundnuts, soybeans, seed cotton and cowpeas is also increased by 1.8, 3.2, 4.8 and 20 times, respectively, as a result of the programme. The expansion in production of these specific crops is compensated for by a decrease in the harvested quantities of cassava and sorghum, whose production falls by more than 90 percent. We do not detect a statistically significant increase of beans production among HGSF beneficiaries. The amount of harvested cowpeas is also left unaffected by the HGSF programme, on average. This is surprising, since beans and peas are the crops targeted by the HGSF's purchasing programme.[12] Groundnuts occupy an important share of the crop portfolio for the HGSF-only beneficiaries and the programme increases their production even further, by almost 110 percent relative to the control group. HGSF-only beneficiaries seem to reduce production of a number of crops. Maize production is reduced by 643 kg on average, or by 33 percent in relative terms, while sorghum production falls to zero from an average of 25 kg per household. For quantities, too, the impacts of the programme on the combined group are similar to those of the CASU-only group. We observe that, contrary to our expectations, there is a lack of complementarity between the CASU and the HGSF programmes on beans and peas production. Given the training support that focuses specifically on pulses and the secured market access, we would have expected the results of the combined group, at least for these crops, to look more similar to those of the HGSF-only group. For maize, the impact of the combined interventions lies halfway between the impact of the CASU intervention alone and that of the HGSF. Maize production is increased by 607 kg, half of the increase observed for the CASU-only group, which in relative terms translates to a 31 percent hike compared with a situation in which none of the programmes were in place. Production expansion of groundnuts, seed cotton, soybeans and sunflowers is much larger in the combined group than in the single programme groups. Harvests of these crops increase by 3.7, 13, 19 and 200 times, respectively. The combination of programmes is associated with a reduction in the production of millet and sorghum.

[12] However, this may be a statistical artefact related to the poor ability of the linear model to capture the true relationship between the intervention and the production of these specific crops.

Table 5: Quantity harvested for main crops, in kg

	CASU	HGSF	Both	Control	CASUvsCtrl	HGSFvsCtrl	BothvsCtrl
Beans	36.152	877.558	32.015	103.195	-90.748	363.076	-94.083
	(9.100)	(510.059)	(7.556)	(9.880)	(307.296)	(318.944)	(381.186)
Cowpeas	26.284	1.944	9.449	0.909	18.962***	0.905	4.428
	(3.152)	(1.027)	(2.300)	(0.397)	(2.886)	(3.021)	(3.585)
Maize	3 404.449	1 357.816	2 718.329	1 931.756	1 291.540***	-643.610***	607.009**
	(178.932)	(94.445)	(133.994)	(83.277)	(195.692)	(205.303)	(240.012)
Cassava	0.827	26.736	5.432	25.755	-26.173***	-0.640	-20.441*
	(0.677)	(5.367)	(2.697)	(4.830)	(8.668)	(9.233)	(10.829)
Groundnuts	206.473	139.694	329.450	63.727	118.907***	69.390**	238.409***
	(15.662)	(11.435)	(24.985)	(15.629)	(27.173)	(29.049)	(33.506)
Millet	0.105	26.987	0.000	14.769	-15.550***	-6.960	-15.668***
	(0.105)	(4.362)	(.)	(1.986)	(4.588)	(4.934)	(5.732)
Seed cotton	52.096	0.000	126.210	8.077	38.974**	-14.170	104.434***
	(9.012)	(.)	(51.327)	(3.869)	(18.504)	(19.918)	(23.081)
Sorghum	0.992	0.000	2.045	24.196	-24.614***	-24.926***	-23.377***
	(0.653)	(.)	(1.825)	(3.894)	(5.118)	(5.527)	(6.392)
Sugar cane	16.097	0.004	115.682	847.081	-1368.337	-1360.078	-1317.197
	(8.224)	(0.004)	(113.650)	(846.023)	(1083.195)	(1169.806)	(1352.897)
Soybeans	113.938	2.441	444.569	23.815	74.230***	-19.327	427.938***
	(15.750)	(1.250)	(36.560)	(7.025)	(22.520)	(24.306)	(27.777)
Sunflowers	25.508	0.148	215.500	0.931	19.743*	-0.895	210.850***
	(5.036)	(0.148)	(20.815)	(0.750)	(11.617)	(12.538)	(14.431)
Potatoes	3.158	6.361	0.000	3.220	2.362	6.630	-0.766
	(1.780)	(4.029)	(.)	(1.682)	(3.876)	(4.183)	(4.838)
Sweet potatoes	211.575	16.753	169.017	30.327	159.557***	-7.601	180.090***
	(26.377)	(3.723)	(34.724)	(4.805)	(30.128)	(32.518)	(37.556)

Note: * 0.1 ** 0.05 ***0.01. Columns 1 to 4 show the post-treatment unconditional averages of the outcome variables. Columns 5 to 7 show, respectively, the average effect of the CASU alone, the HGSF alone and of the combined treatments.

It is useful to look also at the impact of the programmes on the value of harvest computed at market prices in order to enhance comparability across crops as well as to enable the aggregation of the crop portfolio in a single value, both of which would be impossible if we looked only at quantities. Table 6 follows the same structure as the previous Table; it shows results in terms of the value of harvest and confirms most of the impacts obtained by looking at the quantities. Maize is confirmed as the main source of the value of crop production with the exception of the HGSF arm, where beans make up 70 percent of the total value of crop production. None of the programmes or their combinations have an effect on the overall value of crop production.

Table 6: Value of harvest, in ZMK

	CASU	HGSF	Both	Control	CASUvsCtrl	HGSFvsCtrl	BothvsCtrl
Beans	302.595	3 488.421	174.195	574.974	-390.715	1 272.805	-488.200
	(80.312)	(2040.276)	(38.521)	(59.948)	(1232.264)	(1278.973)	(1528.565)
Cowpeas	88.058	0.269	13.612	1.650	68.091***	0.182	7.792
	(10.389)	(0.152)	(3.282)	(0.790)	(8.520)	(8.918)	(10.582)
Maize	3 962.855	1 511.153	3 261.995	2 247.787	1 500.217***	-806.670***	810.196***
	(209.450)	(110.503)	(160.793)	(97.536)	(229.439)	(240.708)	(281.402)
Cassava	2.728	7.905	3.555	31.614	-31.443***	-25.513***	-29.169***
	(2.249)	(1.616)	(1.900)	(5.996)	(8.618)	(9.199)	(10.739)
Groundnuts	331.235	379.749	419.206	167.655	114.332**	195.966***	196.104***
	(26.125)	(31.312)	(33.455)	(32.550)	(52.947)	(56.596)	(65.263)
Millet	0.526	46.481	0.000	36.898	-35.774***	-18.665*	-36.364***
	(0.526)	(8.148)	(.)	(5.350)	(9.592)	(10.317)	(11.980)
Seed cotton	160.840	0.000	323.015	32.311	107.408**	-56.600	260.883***
	(27.707)	(.)	(122.649)	(15.599)	(52.092)	(56.070)	(64.974)
Sorghum	0.000	0.000	3.596	52.814	-52.365***	-52.365***	-50.329***
	(.)	(.)	(3.390)	(8.685)	(11.430)	(12.340)	(14.295)
Sugar cane	15.822	0.000	5.695	31.060	-65.807	-49.870	-42.175
	(7.313)	(0.000)	(5.695)	(31.021)	(40.500)	(43.767)	(50.593)
Soybeans	247.102	0.031	869.109	62.590	151.096***	-52.033	825.981***
	(33.698)	(0.023)	(71.307)	(19.240)	(48.534)	(52.435)	(59.866)
Sunflowers	37.347	0.000	253.215	2.096	26.186*	-2.069	246.407***
	(7.222)	(.)	(24.559)	(1.688)	(13.722)	(14.802)	(17.036)
Potatoes	3.868	23.201	0.000	9.839	0.516	32.387*	-2.961
	(2.178)	(19.262)	(.)	(6.310)	(16.666)	(17.998)	(20.802)
Sweet potatoes	213.742	18.111	126.541	28.799	157.609***	-4.120	128.813***
	(26.429)	(4.754)	(26.029)	(4.943)	(27.401)	(29.575)	(34.155)
Value of harvest	5 324.804	4 903.702	5 367.225	2 944.842	1 569.348	337.832	1 802.437
	(250.057)	(1858.807)	(259.952)	(128.131)	(1257.826)	(1305.506)	(1543.155)

Note: * 0.1 ** 0.05 ***0.01. Columns 1 to 4 show the post-treatment unconditional averages of the outcome variables. Columns 5 to 7 show, respectively, the average effect of the CASU alone, the HGSF alone and of the combined treatments.

To sum up, in the crop sector, CASU leads to increases in the share of farmers producing maize, peas and groundnuts, while reducing the share of beans growers. Harvests of maize, peas and groundnuts increase. The HGSF programme increases the share of beans growers. A smaller share of farmers grows maize, and the amount of maize harvested also drops. In the combined arm, results are often similar to the CASU-only arm. Finally, households in all three arms increase the production of groundnuts.

Livestock production and by-products

This section reports summary statistics and programme impacts for livestock and by-products, which are summarized in Tables 7 to 9. First, in Table 7 we look at binary indicators, recording whether a farm household owns any livestock at all, and at the average number of Tropical Livestock Units (TLUs) owned by the farm household at the time of the survey. The share of farmers engaged in raising livestock is around 80 percent in the CASU-only arm and in the combined arm; it falls to 60 percent in the control arm and to an even lower share of 43 percent in the HGSF-only group. As a result, the average number of TLUs in the HGSF-only group is also relatively low, at 0.5 animals per household. To have an idea of what this implies in terms of the number of actual animals, we note that one milk cow is equivalent to 0.5 TLU and one sheep is equal to 0.1 TLU. In the CASU-only arm the programme leads to an increase of 18 percentage points in the share of farmers raising livestock, which translates to a 60 percent expansion in relative terms. The average herd size also increases by 0.5 TLUs in the CASU-only arm. For the HGSF arm, we observe a reduction in the spread of livestock activities and in the average number of animals owned. The number of farmers dealing with livestock decreases by 23 percent, while herd size is reduced by 88 percent. The impacts in the combined arm are similar to those in the CASU-only arm with even larger changes in herd size, which expands by 102 percent relative to the comparison group.

Table 7: Livestock production

	CASU	HGSF	Both	Control	CASUvsCtrl	HGSFvsCtrl	BothvsCtrl
Any livestock	0.843	0.439	0.803	0.609	0.185***	-0.139***	0.123***
	(0.013)	(0.017)	(0.018)	(0.013)	(0.028)	(0.029)	(0.034)
TLU current (#)	2.360	0.489	2.628	1.137	0.532**	-1.000***	1.159***
	(0.132)	(0.071)	(0.144)	(0.096)	(0.212)	(0.279)	(0.261)

Note: * 0.1 ** 0.05 ***0.01. Columns 1 to 4 show the post-treatment unconditional averages of the outcome variables. Columns 5 to 7 show, respectively, the average effect of the CASU alone, the HGSF alone and of the combined treatments.

In order to have a more detailed view of where the changes in herd size are coming from we look at summary statistics and programme impacts for single animals (Table 8). Households in the CASU and in the combined programme groups each have, on average, at least one milk cow and two other cattle. In the HGSF-only arm, on average, one in every five households has a milk cow and even fewer have other cattle. Goats and chickens play an important role in the livestock sector, with animal stocks ranging between 2 and 5 units for goats and between 6 and 21 units for chicken. The CASU programme is associated with an increase of 115 percent in the average number of milk cows as well as a 50 percent increase in the average number of chickens per household, relative to the comparison group. The HGSF programme is associated with a reduction in the number of other cattle, by 1.28 heads, which is equivalent to a nearly 200 percent decrease relative to the comparison group. Similar noteworthy reductions in the HGSF arm concern the number of goats and chickens, which reduce by 1.82 and 5.5 units, respectively (47 and 43 percent in relative terms). The increased livestock production in the CASU arm may be related to complementarities that CA stimulates between crop and livestock production. Mixed crop-livestock systems are characterized by the

interdependence of crop and livestock production. While the crop component provides feed to the animals, the livestock component provides manure and traction. However, crop and livestock can become substitutes if there are competing uses for crop residues, which are used not only as feed but also as mulch to cover the soil. In our sample, complementarities may be prevailing. In the HGSF arm, the reduced livestock production may be related to the incentive of the market access component to produce and sell pulses, which may attract farmers into these crops and away from maize and livestock or even other income-generating activities. Moreover, it is likely that cereal straw may be preferable to haulm from pulses as livestock fodder. The impacts in the combined arm are different from those of the single programme arms when disaggregated at the level of single animal species. For milk cows and other cattle, the combination of programmes is associated with more sizable increases relative to the CASU treatment alone. The number of other cattle owned almost doubles. This is compensated for by a 53 percent decrease in the number of goats owned.

Table 8: Current animal stocks

	CASU	HGSF	Both	Control	CASUvsCtrl	HGSFvsCtrl	BothvsCtrl
Milk cows	1.042	0.203	1.449	0.420	0.485***	-0.240	0.838***
	(0.110)	(0.120)	(0.125)	(0.093)	(0.183)	(0.226)	(0.226)
Other cattle	2.092	0.086	2.806	0.644	0.409	-1.287***	1.855***
	(0.188)	(0.028)	(0.187)	(0.129)	(0.317)	(0.393)	(0.391)
Sheep	0.068	0.026	0.105	0.069	0.023	-0.043	-0.018
	(0.026)	(0.015)	(0.051)	(0.026)	(0.053)	(0.065)	(0.065)
Goats	5.232	2.444	2.341	3.873	0.464	-1.821***	-2.067***
	(0.290)	(0.165)	(0.231)	(0.300)	(0.500)	(0.622)	(0.617)
Pigs	0.338	0.150	1.242	0.613	-0.336**	-0.484**	0.518**
	(0.069)	(0.044)	(0.175)	(0.094)	(0.163)	(0.210)	(0.201)
Chickens	21.543	6.441	11.199	12.696	6.627***	-5.512***	-1.535
	(1.227)	(0.441)	(0.743)	(0.724)	(1.536)	(1.995)	(1.894)
Guinea fowl	0.738	0.062	0.255	0.189	0.072	-0.262	-0.120
	(0.188)	(0.042)	(0.091)	(0.082)	(0.205)	(0.271)	(0.253)
Rabbits	0.083	0.102	0.083	0.049	0.023	0.163***	0.077
	(0.038)	(0.037)	(0.049)	(0.024)	(0.046)	(0.061)	(0.057)
Ducks&Geese	0.722	0.087	0.369	0.660	-0.384	-0.973**	-0.433
	(0.156)	(0.039)	(0.099)	(0.222)	(0.335)	(0.441)	(0.413)
Other	0.312	0.148	0.402	0.450	0.217	-0.012	0.212
	(0.166)	(0.089)	(0.175)	(0.093)	(0.176)	(0.234)	(0.217)

Note: * 0.1 ** 0.05 ***0.01. Columns 1 to 4 show the post-treatment unconditional averages of the outcome variables. Columns 5 to 7 show, respectively, the average effect of the CASU alone, the HGSF alone and of the combined treatments.

In Table 9 we look at the share of farmers who produced any livestock by-products in the previous 12 months. In the CASU-only arm, 12.3 percent of households answered “yes” to the question of whether they had produced by-products over the 12 months preceding the survey, despite the fact

that almost 85 percent of them own livestock of some kind. Engagement in livestock by-product production is much lower in the rest of the arms, with just 1.6 percent of farmers in the HGSF-only arm and 8.8 percent of farmers in the combined arm dealing in this sector. Both the CASU-only and the combined programmes lead to considerable increases in the share of farmers dealing with by-products, by 1.5 and 1.7 times, respectively. The HGSF produces no significant results for this outcome.

Table 9: Livestock by-products

	CASU	HGSF	Both	Control	CASUvsCtrl	HGSFvsCtrl	BothvsCtrl
Engaged in livestock by-products	0.123	0.016	0.088	0.049	0.074***	-0.024	0.084***
	(0.013)	(0.007)	(0.015)	(0.008)	(0.019)	(0.023)	(0.023)

Note: * 0.1 ** 0.05 ***0.01. Columns 1 to 4 show the post-treatment unconditional averages of the outcome variables. Columns 5 to 7 show, respectively, the average effect of the CASU alone, the HGSF alone and of the combined treatments.

In sum, CASU is associated with increases in herd size and in the share of farmers producing livestock by-products. The HGSF programme reduces herd sizes and the share of farmers owning any livestock at all. Finally, results in the combination arm are similar to the CASU-only arm, if not better in some cases.

Farmers' participation in output markets

In this section we focus on measures of farmers' commercialization by looking at both the extensive (selling some produce in the market) and intensive (sales revenues) aspects of the phenomenon. Table 10 shows summary statistics and programme impacts for a set of binary indicators on whether a farm household sells part of its produce or not, which is the indicator of extensive market participation. Maize and groundnuts are the most widely sold crops in the sample. Between 44 and 63 percent of households sell some maize and between 6 and 36 percent of them sell some groundnuts. Other crops play an important role only for specific arms. The most prominent case concerns beans in the HGSF-only arm, where 71.3 percent of farmers sell them. Soybeans and sunflowers are extensively sold in the combined arm, where 50.9 and 26.5 percent of farmers, respectively, sell some of these crops. The CASU-only treatment is associated with an increase in the share of maize sellers (+29 percent) and a reduction in the share of farmers selling beans (-75 percent). Moreover, CASU leads to an increase in the number of farmers selling groundnuts (2.3 times), soybeans (6 times) and sweet potatoes (2.3 times), while the number of households selling millet and sorghum falls to zero. The share of beans sellers almost doubles as a result of the HGSF programme, as expected, and the number of maize sellers also increases (+20.5 percent). The programme is also associated with positive impacts in the share of farmers selling groundnuts (+2 times), while the share of those selling sorghum shrinks to zero. The impacts of the combined programmes are similar to those of CASU alone, in that they lead to expanding the share of maize sellers and reducing the share of beans sellers. Impacts are larger for some crops, however, compared with each programme in isolation. For instance, the increase in the number of maize (+36

percent), groundnuts (+5 times), sunflower (+120 times) and soybeans (+28 times) sellers is considerably larger than the impacts observed for the single programmes. For beans, we find no evidence of complementarities between HGSF and CASU. The two programmes have opposing effects when applied individually, with CASU leading to a reduction in the share of farmers selling beans. This effect apparently prevails when the two programmes are implemented jointly in the same block.

Table 10: Share of households selling crops

	CASU	HGSF	Both	Control	CASUvsCtrl	HGSFvsCtrl	BothvsCtrl
Beans	0.096	0.713	0.095	0.231	-0.175***	0.462***	-0.162***
	(0.011)	(0.017)	(0.014)	(0.012)	(0.023)	(0.024)	(0.028)
Cowpeas	0.072	0.004	0.045	0.003	0.045***	-0.002	0.026**
	(0.009)	(0.002)	(0.010)	(0.002)	(0.009)	(0.010)	(0.011)
Maize	0.586	0.603	0.626	0.437	0.126***	0.090***	0.156***
	(0.018)	(0.018)	(0.022)	(0.014)	(0.030)	(0.032)	(0.037)
Cassava	0.003	0.013	0.006	0.014	-0.013*	-0.003	-0.003
	(0.002)	(0.004)	(0.004)	(0.003)	(0.007)	(0.007)	(0.008)
Groundnuts	0.227	0.190	0.360	0.062	0.144***	0.125***	0.332***
	(0.015)	(0.015)	(0.022)	(0.007)	(0.023)	(0.024)	(0.028)
Millet	0.001	0.053	0.000	0.033	-0.037***	0.003	-0.039***
	(0.001)	(0.009)	(.)	(0.005)	(0.010)	(0.011)	(0.012)
Seed cotton	0.070	0.000	0.136	0.005	0.062***	-0.009	0.141***
	(0.009)	(.)	(0.016)	(0.002)	(0.011)	(0.011)	(0.013)
Sorghum	0.000	0.000	0.002	0.008	-0.011***	-0.011***	-0.010**
	(.)	(.)	(0.002)	(0.003)	(0.004)	(0.004)	(0.005)
Sugar cane	0.007	0.001	0.002	0.003	-0.009**	-0.004	-0.002
	(0.003)	(0.001)	(0.002)	(0.001)	(0.004)	(0.004)	(0.004)
Soybeans	0.121	0.004	0.509	0.018	0.106***	-0.017	0.504***
	(0.012)	(0.003)	(0.023)	(0.004)	(0.016)	(0.018)	(0.020)
Sunflowers	0.032	0.001	0.265	0.002	0.023**	-0.002	0.247***
	(0.006)	(0.001)	(0.021)	(0.001)	(0.012)	(0.013)	(0.014)
Potatoes	0.003	0.007	0.000	0.005	-0.001	0.001	-0.004
	(0.002)	(0.003)	(.)	(0.002)	(0.004)	(0.004)	(0.005)
Sweet potatoes	0.146	0.025	0.086	0.036	0.083***	-0.018	0.072***
	(0.013)	(0.006)	(0.013)	(0.005)	(0.015)	(0.016)	(0.019)
Other	0.025	0.000	0.006	0.018	0.005	-0.020***	-0.014
	(0.006)	(.)	(0.004)	(0.004)	(0.007)	(0.008)	(0.009)

Note: * 0.1 ** 0.05 ***0.01. Columns 1 to 4 show the post-treatment unconditional averages of the outcome variables. Columns 5 to 7 show, respectively, the average effect of the CASU alone, the HGSF alone and of the combined treatments.

Table 11 shows the findings for the revenues from crops sold in the market, which measures the intensity of farmers' output market involvement. The CASU programme is associated with an increase in average revenues from maize market sales of 39 percent and a reduction in average revenues from beans sales of 87 percent. In this arm, revenues from the sales of groundnuts, seed cotton, soybeans and sweet potatoes also increase substantially, by 1.7, 4.8, 2.7 and 9 times, respectively. The HGSF programme leads to an increase only in revenues from the sale of beans and groundnuts. Specifically, we see that revenues from beans increase by 2.3 times relative to the control group, and revenues from groundnuts by 2.9 times. For all other crops there are no impacts, apart from sorghum, whose sales fall to zero. The coefficient on maize is negative and sizable but statistically insignificant. Results for the combined group show a similar pattern to that of the CASU-only group, in that we see a significant reduction in revenues from beans sales (-71 percent) and an increase in sales revenues from groundnuts (4.9 times), seed cotton (9.4 times), soybeans (15 times) and sweet potatoes (8.8 times). For most of the crops grown by farmers in the combined treatment arm, the impacts are stronger than in any of the two standalone arms. The last row in the table shows results for the total revenues from sales of all crops. We observe that total revenues increase in all three groups, although the impact for the HGSF group is half of that for the combined group. Total crop revenues increase by almost 70 percent for the CASU farmers and by almost 50 percent for HGSF farmers. Crop revenues almost double in value for the combined group.

Table 11: Revenues from crop sales, in ZMK

	CASU	HGSF	Both	Control	CASUvsCtrl	HGSFvsCtrl	BothvsCtrl
Beans	126.452	1 206.020	107.109	340.401	-297.441***	804.082***	-242.748**
	(42.355)	(88.598)	(26.302)	(46.288)	(96.173)	(103.901)	(115.787)
Cowpeas	68.176	0.154	20.994	0.635	61.167**	0.246	4.668
	(26.073)	(0.091)	(9.757)	(0.460)	(25.852)	(26.347)	(31.304)
Maize	2 976.262	1 513.287	2 312.221	2 130.637	839.839**	-357.504	75.694
	(246.334)	(155.580)	(244.092)	(151.061)	(335.827)	(324.150)	(389.103)
Cassava	1.890	9.207	1.144	9.611	-9.645	8.553	-7.807
	(1.346)	(5.126)	(1.144)	(3.163)	(6.534)	(8.074)	(8.121)
Groundnuts	205.864	155.709	262.296	48.831	137.732***	140.423***	233.642***
	(30.109)	(25.688)	(29.168)	(9.661)	(37.201)	(39.699)	(43.945)
Millet	0.263	15.827	0.000	16.351	-8.309	0.819	-8.604
	(0.263)	(4.777)	(.)	(5.605)	(7.725)	(8.510)	(9.630)
Seed cotton	147.023	0.000	213.636	23.206	110.212***	-32.683	217.008***
	(26.025)	(.)	(73.139)	(12.539)	(42.059)	(45.267)	(52.957)
Sorghum	0.000	0.000	2.968	3.018	-3.870**	-3.870*	-2.065
	(.)	(.)	(2.968)	(1.108)	(1.894)	(2.041)	(2.359)
Sugar cane	9.206	0.074	5.682	3.074	-5.332	-5.234	2.435
	(4.993)	(0.074)	(5.682)	(2.388)	(5.381)	(5.805)	(6.709)
Soybeans	230.447	1.051	796.370	47.462	126.086**	-38.339	688.248***
	(39.482)	(0.681)	(73.667)	(17.510)	(51.567)	(55.266)	(63.481)
Sunflowers	29.446	0.000	151.642	2.226	24.293*	-2.025	187.674***
	(11.943)	(.)	(20.690)	(1.851)	(12.880)	(13.758)	(16.691)
Potatoes	1.187	4.039	0.000	3.902	-2.260	2.225	-3.385
	(0.844)	(2.481)	(.)	(1.961)	(3.099)	(3.344)	(3.865)
Sweet potatoes	180.257	6.009	135.370	16.951	158.905***	-7.280	150.459***
	(35.094)	(3.913)	(30.948)	(3.739)	(30.624)	(32.562)	(37.088)
Other	67.731	0.000	6.864	49.400	-25.594	-65.993	-59.612
	(34.456)	(.)	(4.264)	(27.061)	(43.925)	(47.309)	(54.595)
Total revenue	2 722.649	2 111.261	3 291.821	1 439.824	996.218***	714.469**	1 548.270***
	(193.615)	(157.858)	(261.292)	(107.262)	(282.665)	(293.380)	(346.786)

Note: * 0.1 ** 0.05 ***0.01. Columns 1 to 4 show the post-treatment unconditional averages of the outcome variables. Columns 5 to 7 show, respectively, the average effect of the CASU alone, the HGSF alone and of the combined treatments.

Tables 12 and 13 show figures related to the farmers' involvement in the livestock markets in terms of spread and sale revenues, respectively. Table 12 shows that the most traded animals are goats and chickens. Between 10 and 23 percent of farmers have sold some small ruminants in the 12

months preceding the survey, and between 12 and 35 percent of them have sold chickens. CASU alone increases the beneficiaries' market engagement, as they sell more cows (+2.4 times), goats (+60 percent), chickens (+77 percent) and ducks (1.5 times). The HGSF programme is associated mainly with a reduction in the sale of animals. In fact, the share of those selling cattle and pigs drops to zero and the share of those selling chickens drops by 25 percent. In the combined group, there are mixed signals on market engagement. The shares of HGSF beneficiaries who sell milk cows and other cattle increase considerably, by 4 and 10 times, respectively. At the same time the share of goat sellers shrinks by 44 percent.

Table 12: Share of farmers selling animals

	CASU	HGSF	Both	Control	CASUvsCtrl	HGSFvsCtrl	BothvsCtrl
Milk cows	0.043	0.001	0.049	0.009	0.022***	-0.008	0.036***
	(0.007)	(0.001)	(0.010)	(0.003)	(0.008)	(0.009)	(0.010)
Other cattle	0.061	0.001	0.058	0.006	0.024**	-0.023**	0.059***
	(0.009)	(0.001)	(0.011)	(0.002)	(0.010)	(0.010)	(0.012)
Sheep	0.001	0.000	0.002	0.003	-0.000	-0.004	-0.004
	(0.001)	(.)	(0.002)	(0.002)	(0.003)	(0.003)	(0.003)
Goats	0.239	0.098	0.103	0.138	0.083***	-0.035	-0.060**
	(0.015)	(0.010)	(0.014)	(0.009)	(0.022)	(0.022)	(0.026)
Pigs	0.025	0.005	0.062	0.020	0.001	-0.019*	0.048***
	(0.006)	(0.002)	(0.011)	(0.004)	(0.010)	(0.010)	(0.012)
Chickens	0.353	0.127	0.221	0.186	0.144***	-0.048*	0.036
	(0.017)	(0.012)	(0.019)	(0.011)	(0.025)	(0.026)	(0.031)
Guinea fowl	0.009	0.000	0.002	0.002	0.003	-0.002	-0.000
	(0.003)	(.)	(0.002)	(0.001)	(0.003)	(0.003)	(0.004)
Rabbits	0.001	0.002	0.002	0.002	-0.000	0.002	0.000
	(0.001)	(0.002)	(0.002)	(0.001)	(0.003)	(0.003)	(0.003)
Ducks&Geese	0.018	0.002	0.000	0.008	0.012**	-0.004	-0.007
	(0.005)	(0.002)	(.)	(0.002)	(0.005)	(0.005)	(0.006)
Other	0.003	0.004	0.004	0.014	-0.007*	-0.004	-0.006
	(0.002)	(0.002)	(0.003)	(0.003)	(0.004)	(0.004)	(0.005)

Note: * 0.1 ** 0.05 ***0.01. Columns 1 to 4 show the post-treatment unconditional averages of the outcome variables. Columns 5 to 7 show, respectively, the average effect of the CASU alone, the HGSF alone and of the combined treatments.

Table 13 illustrates the impacts of the programmes on revenues from livestock sales. We show only the impact on total revenues since for many animals there were no market transactions and no impacts could be computed. Most of the sales concern cattle, ducks and geese. The CASU programme is associated with a significant increase of revenues from livestock sales, while in the HGSF-only arm we see a reduction. Both findings on livestock sales are in line with the impacts of the programmes on livestock production, which expands under CASU and contracts under HGSF.

Table 13: Revenues from sales of livestock

	CASU	HGSF	Both	Control	CASUvsCtrl	HGSFvsCtrl	BothvsCtrl
Total livestock revenues	1 284.909	76.471	461.917	444.748	480.977**	-456.438**	-37.785
	(238.767)	(9.214)	(56.071)	(74.354)	(200.325)	(207.919)	(245.768)

Note: * 0.1 ** 0.05 ***0.01. Columns 1 to 4 show the post-treatment unconditional averages of the outcome variables. Columns 5 to 7 show, respectively, the average effect of the CASU alone, the HGSF alone and of the combined treatments.

To recap, CASU is associated with increases in the share of farmers selling maize, peas and groundnuts, while reducing the share of beans sellers. Revenues from maize, peas and groundnuts also increase as a result of the programme. The HGSF programme increases the share of beans sellers and the sale revenues from this crop. Overall, HGSF shows fewer impacts in terms of market engagement compared with CASU. Outside of the main crops, the HGSF programme alone leads to an increase in the share of those selling groundnuts and a decrease in the share of those selling sorghum. The CASU programme leads to a mixture of positive and negative impacts for groundnuts, sorghum, millet, seed cotton, soybeans, etc. In terms of revenues, CASU leads to more widespread and mostly positive impacts, while the impacts of HGSF are concentrated mainly on beans and groundnuts. In the combined arm, results for crop sales are similar to the CASU-only arm. Households in all three arms increase total crop sale revenues; this increase is smallest in the HGSF-only arm and largest in the combined arm. CASU also increases the number of animals sold and the corresponding revenues, while HGSF is mainly associated with reduced sales of animals and corresponding revenues. The combined arm shows mixed results when it comes to the sale of animals and no impacts in terms of revenues from livestock sales.

Non-farm businesses (NFBs)

Networking through cooperatives, as well as trust and networking among individuals and with market actors such as WFP, can contribute to entrepreneurship enhancement. Farmer associations, formation of cooperatives, marketing contracts and contract farming also play important roles in the success of start-ups and in creating market linkages to facilitate entrepreneurs' sustainability (Alemu and Adesina, 2017). There are no linkages in the theory of change between CA training and NFB engagement. Despite these theoretical predictions, small non-farm enterprises are an important part of rural livelihoods, especially for the CASU-only group, where almost one in every five households (18.9 percent) runs at least one NFB (Table 14). In the rest of the groups, the presence of non-farm enterprises is much less relevant, especially in the combined arm where only 2.8 percent of the households operate businesses. In terms of impacts, we notice an increase in the share of CASU-only farmers that operate NFBs. HGSF alone has no impacts on farmers' engagement in non-farm activities, while the combination of the two programmes leads to a reduction in famers' NFB engagement. In the CASU-only group, NFBs were operated for less than two months in the previous

year, and for a week in the HGSF and combined groups. Both the self-declared profits and those computed as a difference between self-declared costs and revenues signal an increase in profitability for the CASU-only group and for the combined groups as a result of the corresponding treatments.

Table 14: Non-farm business activities

	CASU	HGSF	Both	Control	CASUvsCtrl	HGSFvsCtrl	BothvsCtrl
Any NFB (share)	0.189	0.041	0.028	0.072	0.076***	-0.016	-0.037*
	(0.014)	(0.007)	(0.008)	(0.007)	(0.017)	(0.018)	(0.021)
Months in operation	1.840	0.241	0.266	0.655	0.974***	-0.252	-0.379*
	(0.153)	(0.050)	(0.086)	(0.073)	(0.179)	(0.185)	(0.219)
Profit (declared) (ZMK)	245.256	33.532	65.529	91.837	110.283*	-2.630	127.949*
	(58.782)	(11.148)	(44.713)	(20.260)	(60.144)	(62.423)	(73.787)
Profit (calculated) (ZMK)	306.498	-8.831	74.458	91.288	115.717	-141.983	146.621
	(89.447)	(24.669)	(63.207)	(86.784)	(147.400)	(152.988)	(180.837)

Note: * 0.1 ** 0.05 *** 0.01. Columns 1 to 4 show the post-treatment unconditional averages of the outcome variables. Columns 5 to 7 show, respectively, the average effect of the CASU alone, the HGSF alone and of the combined treatments.

Labour supply and transfers

In this section we show summary statistics and impacts for paid labour and private transfers, such as remittances or other kinds of transfers. In this report, labour of adults is considered separately from that of children younger than 15 years of age. Table 15 shows sample statistics and impacts for the labour supply by adult male household members in the agricultural and non-agricultural sectors by treatment arm. Participation of adult males in the paid labour market (first row) is generally low and ranges between 2.4 percent in the combined group and 9.1 percent in the CASU group. Most of those who have a paid job work in the non-agricultural sector (second row). Only between 18 and 37 percent of paid jobs are based on a written contract, while the rest rely on informal arrangements (fourth row). Among those who have a paid job, its average duration in the preceding 12 months was between 2.8 and 5.7 months. Almost all adult males have been engaged in farm work (seventh row), regardless of treatment group. In terms of intensity, in the 12 months preceding the survey, adult males worked on their farms for two and a half months and for nine days every month. About two-thirds of the time spent working on the farm is dedicated to crop production. In terms of impacts, CASU is associated with an increase in men's engagement in paid work, while HGSF leads to a reduction in the share of men who do some paid work and in the average job duration. The time spent on the farm by HGSF beneficiaries also shrinks by 6.3 percent. The results in the combined group show the same pattern as in the HGSF group in terms of signs, magnitude and significance.

Table 15: Adult males labour supply

	CASU	HGSF	Both	Control	CASUvsCtrl	HGSFvsCtrl	BothvsCtrl
Paid	0.091	0.025	0.024	0.064	0.033***	-0.049***	-0.049***
	(0.008)	(0.004)	(0.005)	(0.005)	(0.011)	(0.012)	(0.013)
Paid agricultural	0.035	0.011	0.016	0.026	0.025***	-0.024***	-0.017**
	(0.005)	(0.003)	(0.004)	(0.004)	(0.008)	(0.008)	(0.009)
Paid non-agricultural	0.056	0.015	0.008	0.038	0.008	-0.024***	-0.031***
	(0.006)	(0.003)	(0.003)	(0.004)	(0.009)	(0.009)	(0.010)
Formal	0.245	0.324	0.367	0.182	0.036	0.183	-0.155
	(0.037)	(0.078)	(0.089)	(0.033)	(0.067)	(0.162)	(0.144)
Months/Year	5.393	2.829	3.179	5.763	-0.318	-2.982*	-1.602
	(0.374)	(0.472)	(0.587)	(0.390)	(0.726)	(1.777)	(1.552)
Days/Month	17.015	20.629	12.143	17.388	-1.003	-2.495	-4.570
	(0.847)	(3.337)	(2.195)	(0.899)	(1.799)	(4.380)	(3.827)
Farm labour	0.973	0.983	0.989	0.970	0.006	0.015*	0.022**
	(0.004)	(0.004)	(0.003)	(0.004)	(0.008)	(0.008)	(0.009)
Months/Year	2.786	2.489	2.542	2.617	0.121	-0.166**	-0.024
	(0.047)	(0.036)	(0.041)	(0.035)	(0.076)	(0.084)	(0.089)
Days/Month	8.926	8.435	8.556	8.830	-0.348	-0.820***	-0.632*
	(0.160)	(0.146)	(0.162)	(0.126)	(0.278)	(0.309)	(0.325)
Crop time	64.931	65.019	65.272	65.964	-0.330	-0.525	0.272
	(0.599)	(0.650)	(0.703)	(0.493)	(1.100)	(1.225)	(1.284)

Note: * 0.1 ** 0.05 ***0.01. Columns 1 to 4 show the post-treatment unconditional averages of the outcome variables. Columns 5 to 7 show, respectively, the average effect of the CASU alone, the HGSF alone and of the combined treatments.

Table 16 repeats the analysis for adult females. Paid labour market participation among females is lower than for males in the CASU programme and in the control group but similar for the HGSF and combined groups. Also, in contrast to the case for males, paid jobs for women are concentrated in the agriculture sector. Among women who have a paid job, its average duration in the preceding 12 months was between 2.5 and 4.9 months, slightly shorter than for men. As with men, almost all women have been engaged in farm work, regardless of treatment group. In terms of intensity, women's engagement in farm work is similar to that observed for men. In the 12 months preceding the survey, women worked, on average, for two and a half months on their farms and for nine days per month. In terms of impacts, CASU is associated with an increase in women's engagement in paid agricultural labour, while the HGSF programme and the combination have no significant impacts on women's labour supply.

Table 16: Adult females labour supply

	CASU	HGSF	Both	Control	CASUvsCtrl	HGSFvsCtrl	BothvsCtrl
Paid	0.053	0.020	0.024	0.028	0.018**	-0.005	0.006
	(0.006)	(0.004)	(0.005)	(0.004)	(0.009)	(0.009)	(0.010)
Paid agricultural	0.035	0.014	0.023	0.015	0.015**	-0.004	0.013
	(0.005)	(0.003)	(0.005)	(0.003)	(0.007)	(0.008)	(0.008)
Paid non-agricultural	0.018	0.007	0.001	0.013	0.002	-0.001	-0.007
	(0.003)	(0.002)	(0.001)	(0.002)	(0.005)	(0.005)	(0.006)
Formal	0.133	0.206	0.310	0.246	-0.111	0.094	0.097
	(0.037)	(0.070)	(0.087)	(0.054)	(0.095)	(0.159)	(0.146)
Months/Year	4.112	2.500	2.857	4.902	-0.468	-0.502	-0.299
	(0.399)	(0.529)	(0.511)	(0.545)	(0.935)	(1.675)	(1.451)
Days/Month	14.506	13.533	11.321	17.164	2.011	9.878*	-3.933
	(1.221)	(4.069)	(2.065)	(1.644)	(3.331)	(5.968)	(5.170)
Farm labour	0.982	0.987	0.989	0.987	-0.007	0.001	-0.008
	(0.003)	(0.003)	(0.003)	(0.002)	(0.006)	(0.006)	(0.007)
Months/Year	2.658	2.464	2.601	2.528	-0.000	-0.032	0.021
	(0.040)	(0.035)	(0.040)	(0.027)	(0.064)	(0.072)	(0.078)
Days/Month	8.960	8.529	8.478	8.613	-0.268	-0.401	0.114
	(0.146)	(0.137)	(0.167)	(0.111)	(0.252)	(0.280)	(0.306)
Crop time	65.353	65.059	64.763	66.169	-1.633	-1.023	-2.966**
	(0.587)	(0.616)	(0.698)	(0.472)	(1.067)	(1.184)	(1.292)

Note: * 0.1 ** 0.05 ***0.01. Columns 1 to 4 show the post-treatment unconditional averages of the outcome variables. Columns 5 to 7 show, respectively, the average effect of the CASU alone, the HGSF alone and of the combined treatments.

Private transfers in cash, food, farming inputs or labour are a good indicator of the strength of the social and economic ties among households in the community. Since both CASU and HGSF have a productive support orientation that is expected to affect farm production directly, they may have second order effects on the exchange of free transfers of food, inputs or cash. The most common type of transfer that households receive consists of farm inputs. Between 8 and 34 percent of households received some inputs from community members (Table 17). The least common type of received transfer is cash from non-family members. Households more frequently provide food transfers compared with other types of transfers; between 8.8 and 43.9 percent of them do so. In terms of impacts, CASU is associated with increases in the receipt and provision of almost all types of transfers. In particular, the share of households that receive some farm inputs for free increases by 82 percent, while the impact on those who give out food as a transfer to other community members increases by 103 percent. The impacts of HGSF go in the opposite direction – reducing exchanges of private transfers for almost all types. The share of households that receive some farm inputs shrinks by 68 percent.

Table 17: Private transfers

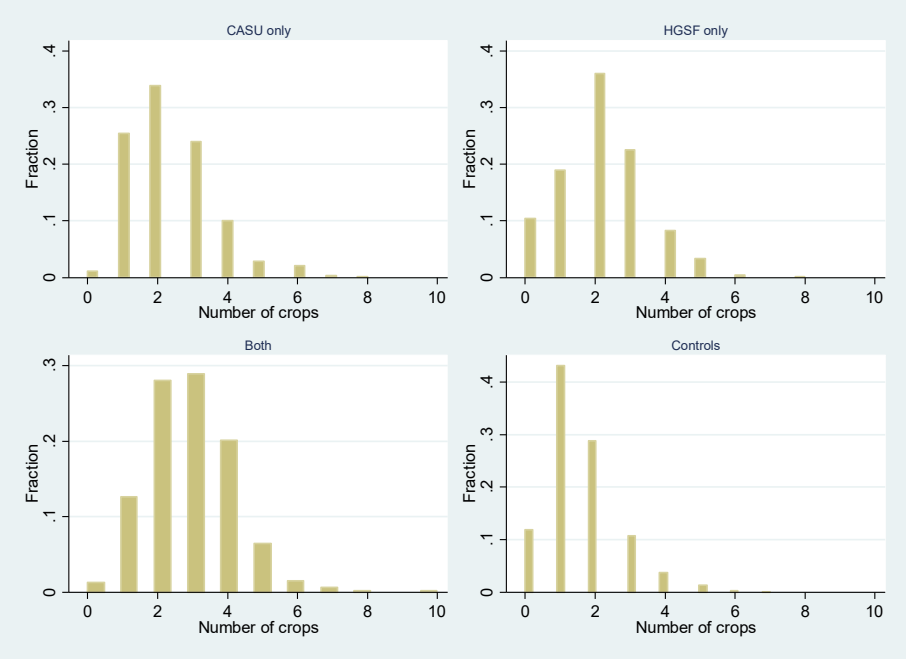
	CASU	HGSF	Both	Control	CASUvsCtrl	HGSFvsCtrl	BothvsCtrl
Received cash from family members	0.194	0.031	0.054	0.101	0.085***	-0.069***	-0.028
	(0.014)	(0.006)	(0.010)	(0.008)	(0.019)	(0.019)	(0.023)
Received cash from non-family members	0.159	0.038	0.077	0.090	0.070***	-0.044**	0.003
	(0.013)	(0.007)	(0.012)	(0.008)	(0.018)	(0.019)	(0.022)
Received food	0.202	0.043	0.092	0.117	0.112***	-0.039*	0.003
	(0.015)	(0.007)	(0.013)	(0.009)	(0.020)	(0.021)	(0.024)
Received labour	0.173	0.044	0.126	0.087	0.093***	-0.037**	0.017
	(0.014)	(0.007)	(0.015)	(0.008)	(0.018)	(0.019)	(0.022)
Received inputs	0.343	0.079	0.163	0.155	0.127***	-0.090***	0.025
	(0.017)	(0.009)	(0.017)	(0.010)	(0.023)	(0.024)	(0.028)
Provided cash to family members	0.258	0.031	0.064	0.100	0.143***	-0.104***	-0.058**
	(0.016)	(0.006)	(0.011)	(0.008)	(0.019)	(0.020)	(0.024)
Provided cash to non-family members	0.230	0.039	0.136	0.119	0.143***	-0.086***	0.030
	(0.015)	(0.007)	(0.016)	(0.009)	(0.021)	(0.022)	(0.025)
Provided food	0.439	0.088	0.198	0.214	0.222***	-0.129***	-0.064**
	(0.018)	(0.010)	(0.019)	(0.011)	(0.025)	(0.027)	(0.031)
Provided labour	0.210	0.051	0.153	0.137	0.083***	-0.082***	-0.003
	(0.015)	(0.008)	(0.017)	(0.010)	(0.021)	(0.023)	(0.026)
Provided inputs	0.180	0.074	0.119	0.116	0.062***	-0.013	0.034
	(0.014)	(0.009)	(0.015)	(0.009)	(0.020)	(0.022)	(0.025)

Note: * 0.1 ** 0.05 ***0.01. Columns 1 to 4 show the post-treatment unconditional averages of the outcome variables. Columns 5 to 7 show, respectively, the average effect of the CASU alone, the HGSF alone and of the combined treatments.

Crop diversification

Diversified crop production is a precondition for good nutrition in that a diversity of foods is available and affordable for all individuals at all times. On the other hand, excessive intensification, which often results in monoculture, risks simplifying diets and worsening nutrition in producer communities (FAO, 2017). Diversified crop production can help increase direct access to micronutrients, proteins and nutrient-dense varieties of vegetables, which might otherwise be expensive or difficult to acquire, particularly for poor people. We use two indicators to measure the current level of diversity of foods produced on farm: the number of crop species cultivated by the farm household over the last 12 months and the Simpson index, based on the value of each crop produced. The first indicator has a straightforward interpretation since the larger the number of crops produced on the farm, the more diverse the food that is potentially available to the household. The Simpson index is a general index of diversity, which takes into account both the quantity produced of each crop and the number of crops. It is computed for each household using the value of each harvested crop at market prices.

Figure 5: Distribution of the number of grown crops by group



The index ranges between 0 and 1. As a result, a farmer who produces the same quantity of two different crops will be less diversified than a farmer who harvests the same quantity from three different crops. The index reaches the lower boundary when the farmer produces only one crop, while it is equal to the maximum when the value of harvest is the same for every grown crop. Figure 5 shows the distribution of the number of grown crops by treatment arm. In all arms, the majority of farmers grow between one and two crops. The combined group is notable for a higher share of farmers who grow more than three crops.

In Table 18, we see that, overall, each farmer grows between one and a half and almost three crops on average, while the Simpson index is below 0.5 for all four groups. This suggests that farmers are scarcely diversified in terms of both value of harvested quantities and number of grown crops. The CASU programme, the HGSF programme and their combination are associated with an increase in crop diversification in terms of both indicators. For instance, the CASU-only treatment increases the number of grown crops by 29.2 percent, while HGSF leads to a 33.5 percent increase in the number of grown crops.

Table 18: Crop diversification

	CASU	HGSF	Both	Control	CASUvsCtrl	HGSFvsCtrl	BothvsCtrl
Simpson (value)	0.301	0.436	0.425	0.298	0.046***	0.155***	0.213***
	(0.009)	(0.010)	(0.010)	(0.009)	(0.015)	(0.015)	(0.018)
Number crops	2.360	2.121	2.854	1.568	0.458***	0.526***	1.147***
	(0.045)	(0.044)	(0.061)	(0.030)	(0.067)	(0.070)	(0.083)

Note: * 0.1 ** 0.05 ***0.01. Columns 1 to 4 show the post-treatment unconditional averages of the outcome variables. Columns 5 to 7 show, respectively, the average effect of the CASU alone, the HGSF alone and of the combined treatments.

Gross income

This section focuses on gross income, defined as the sum of the market value of all crops, the income from wage labour and the revenues from sales of livestock and livestock by-products, as well as sales from NFBs. The HGSF programme leads to a reduction in gross income of 40 percent (Table 19). The decrease can be attributed to the negative effects of the programme on livestock income and on wage income. The combined treatment increases gross income by 42.8 percent. CASU has no statistically significant impact on gross income but it does lead to an increase in livestock income.

Table 19: Gross income and its components

	CASU	HGSF	Both	Control	CASUvsCtrl	HGSFvsCtrl	BothvsCtrl
Gross income	8 818.315	3 494.991	7 164.101	4 939.623	1 007.029	-1999.853**	2 118.716*
	(501.353)	(178.786)	(696.323)	(545.073)	(948.484)	(984.005)	(1163.049)
Value of crops	5 594.862	3 210.492	6,091.775	3,488.978	871.702	-830.551	1 314.595
	(291.670)	(155.175)	(524.907)	(520.711)	(794.177)	(823.919)	(973.835)
Livestock sales	643.293	38.283	232.072	220.188	244.327**	-224.935**	-15.607
	(119.536)	(4.612)	(28.033)	(37.142)	(100.237)	(103.991)	(122.912)
Livestock by-product sales	1 374.315	126.875	900.000	284.152	831.476	-253.692	-1114.410
	(357.870)	(124.746)	(717.670)	(86.779)	(771.141)	(3439.374)	(1043.096)
NFB sales	464.197	52.373	478.437	289.331	148.875	-95.345	1 436.109***
	(101.709)	(16.330)	(429.235)	(89.857)	(321.047)	(333.071)	(393.674)
Wage income	1 970.637	192.588	298.219	931.240	-327.796	-836.750**	-693.358
	(319.768)	(84.563)	(89.739)	(121.582)	(357.378)	(370.762)	(438.224)

Note: * 0.1 ** 0.05 ***0.01. Columns 1 to 4 show the post-treatment unconditional averages of the outcome variables. Columns 5 to 7 show, respectively, the average effect of the CASU alone, the HGSF alone and of the combined treatments.

5.2. Production inputs and assets

This section is dedicated to the fixed and variable input endowments of the farm households. In particular, we present summary statistics for land, variable inputs, agricultural assets and services, durable assets and access to credit.

Land holdings and use

Table 20 shows that across the four groups, between 90 and 99 percent of households cultivate some land. The average area of operated land is between 3.1 and 5.8 hectares. It appears that farmers in the CASU group and the combined group are better endowed with land, relative to the other two groups. The programmes had no impacts either on the share of those cultivating or on the average area of cultivated land, aside from a small reduction in the area of operated land caused by the CASU programme.

Table 20: Farming land holdings

	CASU	HGSF	Both	Control	CASUvsCtrl	HGSFvsCtrl	BothvsCtrl
Cultivator (share)	0.996	0.907	0.998	0.901	0.001	0.001	0.001
	(0.002)	(0.010)	(0.002)	(0.008)	(0.002)	(0.002)	(0.003)
Operated land (ha)	5.835	3.779	5.122	3.163	-0.028**	0.014	0.009
	(0.396)	(0.257)	(1.208)	(0.268)	(0.013)	(0.014)	(0.016)

Note: * 0.1 ** 0.05 ***0.01. Columns 1 to 4 show the post-treatment unconditional averages of the outcome variables. Columns 5 to 7 show, respectively, the average effect of the CASU alone, the HGSF alone and of the combined treatments.

Table 21 shows results for land allocation across crops. In the CASU group, 76 percent of land goes to maize cultivation and the remaining part is split between groundnuts, soybeans and other crops. In the HGSF group, only 36.6 percent of land is planted with maize, while beans cover the lion's share (44 percent). In the combined group, the distribution of land is less concentrated, with 58.5 percent planted with maize, 13.8 percent with soybeans and 11.2 percent with groundnuts. In terms of effects, CASU is associated with a small increase (+6.7 percent) in the share of operated land dedicated to maize cultivation at the expense of land dedicated to beans. The inverse pattern is true for the HGSF treatment, which leads to a considerable increase in the share of land dedicated to beans at the expense of maize. The results for the combined group show a reduction in the share of land dedicated to both maize and beans. Farmers in this group increase resources dedicated to soybeans, groundnuts and sunflowers.

Table 21: Land allocation

	CASU	HGSF	Both	Control	CASUvsCtrl	HGSFvsCtrl	BothvsCtrl
Beans	0.026	0.440	0.026	0.116	-0.111***	0.326***	-0.113***
	(0.003)	(0.011)	(0.005)	(0.006)	(0.012)	(0.012)	(0.015)
Cowpeas	0.019	0.001	0.007	0.002	0.014***	-0.001	0.003
	(0.002)	(0.001)	(0.001)	(0.001)	(0.002)	(0.002)	(0.003)
Maize	0.767	0.366	0.585	0.744	0.050***	-0.385***	-0.174***
	(0.008)	(0.010)	(0.012)	(0.009)	(0.016)	(0.017)	(0.020)
Cassava	0.001	0.088	0.002	0.024	-0.025***	0.067***	-0.023***
	(0.000)	(0.006)	(0.001)	(0.003)	(0.006)	(0.007)	(0.008)
Groundnuts	0.081	0.096	0.112	0.036	0.046***	0.062***	0.079***
	(0.005)	(0.006)	(0.007)	(0.003)	(0.008)	(0.008)	(0.010)
Cashew nuts	0.000	0.000	0.000	0.000	-0.000	-0.000	-0.000
	(0.000)	(.)	(.)	(0.000)	(0.000)	(0.000)	(0.000)
Millet	0.000	0.021	0.000	0.016	-0.015***	0.005	-0.016***
	(0.000)	(0.003)	(.)	(0.002)	(0.003)	(0.004)	(0.004)
Seed cotton	0.016	0.000	0.032	0.002	0.016***	-0.004	0.039***
	(0.003)	(.)	(0.004)	(0.001)	(0.003)	(0.003)	(0.004)
Sorghum	0.001	0.000	0.001	0.030	-0.029***	-0.029***	-0.026***
	(0.000)	(.)	(0.001)	(0.004)	(0.005)	(0.006)	(0.006)
Sugar cane	0.002	0.000	0.000	0.000	-0.005***	-0.001	-0.000
	(0.001)	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)	(0.002)
Rice	0.000	0.000	0.001	0.000	-0.000	-0.000	0.000
	(.)	(.)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Soybeans	0.034	0.001	0.138	0.008	0.025***	-0.007	0.142***
	(0.004)	(0.001)	(0.008)	(0.002)	(0.005)	(0.006)	(0.007)
Tobacco	0.000	0.000	0.002	0.000	-0.000	-0.000	0.002***
	(.)	(.)	(0.001)	(0.000)	(0.000)	(0.000)	(0.001)
Sunflower	0.011	0.000	0.082	0.001	0.008**	-0.002	0.081***
	(0.002)	(0.000)	(0.006)	(0.001)	(0.004)	(0.004)	(0.005)
Tea	0.000	0.001	0.000	0.000	0.000	0.001*	0.000
	(.)	(0.001)	(.)	(.)	(0.001)	(0.001)	(0.001)
Coffee	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	(.)	(.)	(.)	(.)	(.)	(.)	(.)
Flowers	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	(.)	(.)	(.)	(.)	(.)	(.)	(.)
Potatoes	0.001	0.001	0.000	0.001	0.001	0.001*	-0.000
	(0.000)	(0.001)	(.)	(0.000)	(0.001)	(0.001)	(0.001)
Sweet potatoes	0.034	0.008	0.019	0.009	0.024***	0.000	0.015***
	(0.003)	(0.001)	(0.003)	(0.001)	(0.004)	(0.004)	(0.005)
Other	0.010	0.000	0.004	0.010	-0.002	-0.008**	-0.005
	(0.002)	(0.000)	(0.002)	(0.002)	(0.003)	(0.004)	(0.004)

Note: * 0.1 ** 0.05 ***0.01. Columns 1 to 4 show the post-treatment unconditional averages of the outcome variables. Columns 5 to 7 show, respectively, the average effect of the CASU alone, the HGSF alone and of the combined treatments.

Use of variable inputs, agricultural assets and services

In this section we look at use of agricultural inputs. Table 22 shows that the shares of those who use chemical fertilizers in the HGSF and control groups are particularly low – between 26 and 38 percent. The shares of farmers who use chemical fertilizers in the CASU group and in the combined arm are the highest in the sample – 84.6 and 67.2 percent, respectively. A similar intergroup pattern is observed for organic fertilizers, for pesticides and for expenditures for hired labour, storage and transportation. The finding of a higher share of CASU farmers who use hired labour is in line with expectations, given the more labour-intensive nature of CA activities, while higher use of the other inputs testifies to a higher productive engagement by the CASU and combined groups. In terms of impacts, the CASU programme is associated with an increase in the share of users of chemical and organic fertilizers and in the share of households that hire labour. The HGSF programme is associated with a reduction in the share of users of fertilizers and pesticides, as well as of hired labour. In the combined group, results are similar to the CASU-only group, if not stronger, as in the case of the increased use of organic fertilizers.

Table 22: Share of farmers using variable crop inputs

	CASU	HGSF	Both	Control	CASUvsCtrl	HGSFvsCtrl	BothvsCtrl
Chemical fertilizer	0.846	0.260	0.672	0.383	0.427***	-0.150***	0.328***
	(0.013)	(0.016)	(0.022)	(0.014)	(0.027)	(0.028)	(0.033)
Organic fertilizer	0.159	0.016	0.309	0.037	0.094***	-0.020	0.308***
	(0.013)	(0.004)	(0.021)	(0.005)	(0.018)	(0.018)	(0.022)
Pesticides & herbicides	0.497	0.027	0.247	0.147	0.337***	-0.125***	0.100***
	(0.018)	(0.006)	(0.020)	(0.010)	(0.024)	(0.024)	(0.029)
Hired crop labour	0.328	0.092	0.260	0.136	0.140***	-0.065***	0.183***
	(0.017)	(0.010)	(0.020)	(0.010)	(0.024)	(0.025)	(0.029)
Land rental	0.021	0.014	0.028	0.013	0.006	0.003	0.046***
	(0.005)	(0.004)	(0.008)	(0.003)	(0.009)	(0.009)	(0.011)
Storage	0.346	0.065	0.519	0.168	0.181***	-0.086***	0.403***
	(0.017)	(0.009)	(0.023)	(0.011)	(0.024)	(0.025)	(0.030)
Transport	0.303	0.101	0.373	0.151	0.118***	-0.105***	0.227***
	(0.017)	(0.011)	(0.022)	(0.010)	(0.024)	(0.025)	(0.030)

Note: * 0.1 ** 0.05 ***0.01. Columns 1 to 4 show the post-treatment unconditional averages of the outcome variables. Columns 5 to 7 show, respectively, the average effect of the CASU alone, the HGSF alone and of the combined treatments.

Table 23 repeats the analysis for livestock inputs. The share of users of manufactured feed is clearly higher in the HGSF and combined groups, although very low in absolute terms. Only 4.3 percent of CASU farmers use manufactured feed, for instance. The same intergroup pattern is observed for

veterinary services and hired labour, but with higher absolute values. In fact, around 15.9 percent of CASU farmers use veterinary services, compared with 6.1 percent in the HGSF group. In terms of impacts, the CASU programme and the combination of programmes lead to an increase in almost all variable livestock inputs, while HGSF has no impact across all inputs.

Table 23: Share of farmers using variable livestock inputs

	CASU	HGSF	Both	Control	CASUvsCtrl	HGSFvsCtrl	BothvsCtrl
Fodder	0.027	0.016	0.019	0.005	0.018**	0.014*	0.011
	(0.006)	(0.004)	(0.006)	(0.002)	(0.007)	(0.008)	(0.009)
Manufactured feed	0.043	0.004	0.060	0.004	0.032***	0.002	0.093***
	(0.007)	(0.002)	(0.011)	(0.002)	(0.009)	(0.009)	(0.010)
Veterinary services	0.159	0.019	0.384	0.029	0.125***	-0.020	0.386***
	(0.013)	(0.005)	(0.023)	(0.005)	(0.018)	(0.018)	(0.022)
Water	0.182	0.061	0.403	0.088	0.124***	-0.016	0.431***
	(0.014)	(0.009)	(0.023)	(0.008)	(0.021)	(0.022)	(0.026)
Hired labour for livestock	0.125	0.079	0.215	0.040	0.047***	0.008	0.238***
	(0.012)	(0.010)	(0.019)	(0.006)	(0.018)	(0.019)	(0.022)

Note: * 0.1 ** 0.05 ***0.01. Columns 1 to 4 show the post-treatment unconditional averages of the outcome variables. Columns 5 to 7 show, respectively, the average effect of the CASU alone, the HGSF alone and of the combined treatments.

Assets and agricultural tools are crucial inputs for farm production. Table 24 shows that tractors and cultivators are used more in the CASU group relative to the rest of the sample, although the absolute numbers are low. Also, in terms of impacts, the CASU programme seems to stimulate the use of mechanized machinery, while the other two treatments have zero effects on these outcomes. This is contrary, however, to what would be expected from CA farmers, given that one of CA's most popular techniques is zero tillage and minimum soil disturbance. However, only 6.7 percent of CASU farmers use tractors. The use of hired pack or traction animals seems much more common than use of tractors. CASU alone and in combination with HGSF are associated with an increased use of Scotch carts and of hired pack animals.

Table 24: Share of farmers using assets and services for crops

	CASU	HGSF	Both	Control	CASUvsCtrl	HGSFvsCtrl	BothvsCtrl
Tractor	0.067	0.000	0.006	0.020	0.051***	-0.017	-0.010
	(0.009)	(.)	(0.004)	(0.004)	(0.010)	(0.010)	(0.012)
Cultivator	0.041	0.001	0.056	0.009	0.023**	-0.016*	0.048***
	(0.007)	(0.001)	(0.011)	(0.003)	(0.009)	(0.010)	(0.011)
Planter	0.003	0.000	0.002	0.001	-0.002	-0.000	0.002
	(0.002)	(.)	(0.002)	(0.001)	(0.002)	(0.002)	(0.003)
Hired animal	0.203	0.000	0.099	0.060	0.096***	-0.067***	0.062***
	(0.015)	(.)	(0.014)	(0.007)	(0.017)	(0.017)	(0.020)
Scotch cart	0.339	0.000	0.412	0.077	0.224***	-0.100***	0.369***
	(0.017)	(.)	(0.023)	(0.008)	(0.021)	(0.022)	(0.026)
Other assets	0.005	0.080	0.049	0.034	-0.030**	0.039***	0.024
	(0.003)	(0.010)	(0.010)	(0.005)	(0.013)	(0.013)	(0.016)

Note: * 0.1 ** 0.05 ***0.01. Columns 1 to 4 show the post-treatment unconditional averages of the outcome variables. Columns 5 to 7 show, respectively, the average effect of the CASU alone, the HGSF alone and of the combined treatments.

Farmer's participation in input markets

Variable inputs in agriculture can be bought in the market for a price, produced on the farm (seeds, tillage, harvest, etc.) or obtained as gifts through private transfers. In this section we focus on the degree of farmers' commercialization or of input market participation. In particular, in Table 25 we look at the share of farmers who buy a certain input in the market. For instance, although every farmer in the CASU and combined groups uses maize seeds (Table 24), only 74.8 and 38.4 percent of them, respectively, buy these seeds in the market. Further, while 87.6 percent of HGSF farmers use bean seeds, only 22.3 of them buy these seeds. The rest of these farmers must be either producing the seeds on their own or obtaining them through private gifts. A similar discrepancy between the share of users and buyers of a certain input is also observed for chemical and organic fertilizers and for pesticides, as well as for hired labour. This is in line with other findings on private transfers (see Section 6.5), which show that farmers do indeed give to and receive from each other all sorts of farm inputs for free, from seeds to labour. In terms of impacts, CASU is associated with increased input market participation, especially for maize seeds, chemical fertilizers, hired labour and transportation services. The HGSF programme is associated with reduced input market engagement, especially for maize seeds, chemical fertilizers and transportation services. Impacts for the combined arm are similar to those of the CASU-only arm.

Table 25: Share of farmers purchasing variable crop inputs

	CASU	HGSF	Both	Control	CASUvsCtrl	HGSFvsCtrl	BothvsCtrl
Maize seeds	0.748	0.223	0.384	0.316	0.409***	-0.133***	0.111***
	(0.016)	(0.015)	(0.023)	(0.013)	(0.027)	(0.028)	(0.034)
Bean seeds	0.039	0.052	0.019	0.025	0.011	0.019	0.019
	(0.007)	(0.008)	(0.006)	(0.004)	(0.012)	(0.012)	(0.014)
Chemical fertilizer	0.559	0.172	0.470	0.237	0.332***	-0.104***	0.265***
	(0.018)	(0.014)	(0.023)	(0.012)	(0.027)	(0.028)	(0.034)
Organic fertilizer	0.020	0.010	0.109	0.005	0.013	0.002	0.107***
	(0.005)	(0.004)	(0.014)	(0.002)	(0.009)	(0.010)	(0.011)
Pesticides & herbicides	0.195	0.013	0.127	0.056	0.094***	-0.060***	0.065***
	(0.014)	(0.004)	(0.015)	(0.006)	(0.017)	(0.018)	(0.021)
Hired crop labour	0.184	0.061	0.144	0.074	0.096***	-0.022	0.096***
	(0.014)	(0.009)	(0.016)	(0.007)	(0.019)	(0.020)	(0.024)
Land rental	0.010	0.004	0.011	0.007	0.006	-0.002	0.042***
	(0.004)	(0.002)	(0.005)	(0.002)	(0.006)	(0.006)	(0.007)
Storage	0.016	0.014	0.097	0.016	-0.014	0.005	0.089***
	(0.004)	(0.004)	(0.014)	(0.004)	(0.010)	(0.010)	(0.012)
Transport	0.197	0.063	0.210	0.087	0.117***	-0.050**	0.158***
	(0.014)	(0.009)	(0.019)	(0.008)	(0.020)	(0.021)	(0.025)

Note: * 0.1 ** 0.05 ***0.01. Columns 1 to 4 show the post-treatment unconditional averages of the outcome variables. Columns 5 to 7 show, respectively, the average effect of the CASU alone, the HGSF alone and of the combined treatments.

Table 26 shows the average expenditure over the agricultural season that farmers bear for each input. For CASU farmers, the highest shares of expenditure go for chemical fertilizers (ZMW 1018) and for maize seeds (ZMW 529). A smaller amount, around ZMK 100, goes for pesticides, hired

labour and transport. Farmers in the combined group show a similar spending pattern on inputs, with even higher amounts spent on chemical fertilizers. For HGSF farmers, the amounts spent for maize seeds and chemical fertilizers – the most valuable inputs – are considerably smaller, at ZMW 198 and ZMW 105, respectively. In terms of impacts, the CASU programme is associated with increased spending on maize seeds, pesticides and transportation. HGSF is associated with reduced spending on maize seeds and pesticides, compensated for by an increase in expenditure for bean seeds. Farmers under the combined treatment increase expenditure for organic fertilizers, land rental and storage. The last row of the Table shows the total crop expenditure. The CASU and the combined arms spend much more on input purchases than the rest of the sample. CASU is also associated with a significant increase in total crop input expenditure.

Table 26: Expenditure on variable crop inputs

	CASU	HGSF	Both	Control	CASUvsCtrl	HGSFvsCtrl	BothvsCtrl
Maize seeds	529.638	168.727	383.797	272.218	190.004***	-157.266***	31.827
	(30.317)	(23.771)	(28.951)	(15.465)	(43.475)	(52.996)	(60.547)
Bean seeds	4.774	43.667	2.835	9.259	-3.247	74.835***	-2.202
	(1.220)	(9.602)	(1.616)	(4.586)	(6.703)	(16.125)	(8.006)
Other seeds	19.813	0.000	4.635	1.340	12.808***	-1.684	0.991
	(3.969)	(.)	(2.898)	(0.547)	(3.210)	(3.349)	(3.938)
Chemical fertilizer	1 018.630	105.435	1 703.772	290.457	559.169	-295.359	-46.389
	(68.738)	(10.260)	(1222.986)	(32.608)	(348.933)	(340.496)	(419.621)
Organic fertilizer	10.129	5.656	106.515	1.708	14.347	1.844	95.617***
	(5.523)	(2.538)	(29.519)	(0.974)	(13.556)	(13.512)	(17.871)
Pesticides & herbicides	96.611	0.430	38.641	19.051	43.429***	-34.800***	16.668
	(12.295)	(0.219)	(6.308)	(3.201)	(11.175)	(10.208)	(12.666)
Hired crop labour	97.600	25.467	60.502	70.560	38.016	-44.147	10.179
	(11.067)	(6.161)	(9.866)	(18.100)	(27.087)	(27.030)	(33.792)
Land rental	3.904	0.392	5.240	2.137	1.470	-1.558	8.645***
	(1.791)	(0.226)	(3.499)	(0.813)	(2.265)	(2.351)	(2.779)
Storage	3.049	1.316	23.056	1.083	0.892	0.290	24.260***
	(1.169)	(0.382)	(4.455)	(0.468)	(2.128)	(1.979)	(2.946)
Transport	110.200	27.883	42.095	36.147	46.854**	-30.217	3.360
	(19.082)	(8.399)	(7.128)	(5.801)	(18.686)	(19.049)	(23.670)
Total crop expenditure	1 420.934	227.850	1 753.188	474.581	776.806***	-399.915	183.554
	(84.796)	(25.028)	(979.045)	(41.565)	(288.128)	(299.050)	(353.488)

Note: * 0.1 ** 0.05 ***0.01. Columns 1 to 4 show the post-treatment unconditional averages of the outcome variables. Columns 5 to 7 show, respectively, the average effect of the CASU alone, the HGSF alone and of the combined treatments.

In Table 27, we focus on the value of inputs that are not obtained through the market but through the other two channels – i.e. produced on-farm or received by farmers for free through (mostly)

private transfers. The value of maize seeds self-produced or obtained for free varies between 54 and 125 percent of the value of maize seeds bought by CASU and HGSF farmers, respectively. For beans, the value of seeds obtained through non-market channels varies between 3 and 4 times the value of purchased seeds. For chemical fertilizers, which clearly cannot be produced in-house, the value of inputs obtained for free through transfers is as large as 70 percent of purchased fertilizer for CASU farmers, 30 percent for the combined group and twice the value of purchased fertilizer for the HGSF group. Farmers satisfy only between one-third and one-half of their needs for inputs through market purchases, with the rest of requirements being met through free transfers or home-produced. In terms of impacts, CASU is associated with an increase of chemical fertilizers obtained through transfers, probably those given out by the programme itself through vouchers. HGSF has a positive impact on the value of bean seeds and of transportation services that are obtained through transfers or own production and a negative impact on the value of chemical fertilizer received through transfers. The combined treatment is associated with an increased use of chemical and organic fertilizers and of pesticides. The total value of inputs obtained through free transfers or produced at home, shown in the last row of the Table, is similar across the three treatment groups and considerably lower in the control group. However, only CASU and the combined treatment lead to an increase in the total value of inputs not obtained through market purchases. For beneficiaries of the CASU programme and the combined treatment, half of the inputs are purchased on the market while the other half are obtained through free transfers or home-produced. For HGSF beneficiaries, the value of inputs purchased is just 14 percent of the total value of crop inputs used. Overall, the degree of market participation on the input side seems relatively low, especially for the HGSF beneficiaries.

Table 27: Value of variable crop inputs home-produced or received for free

	CASU	HGSF	Both	Control	CASUvsCtrl	HGSFvsCtrl	BothvsCtrl
Maize seeds	284.249	211.908	358.288	190.833	80.159*	8.435	80.164
	(20.404)	(21.638)	(60.078)	(12.671)	(45.207)	(53.944)	(55.334)
Bean seeds	16.092	120.948	16.300	23.706	-8.916	95.839***	-4.242
	(2.501)	(20.677)	(4.528)	(5.320)	(11.124)	(14.808)	(13.425)
Cowpeas	7.965	0.052	3.715	0.390	6.974***	-0.233	-0.187
	(1.348)	(0.037)	(1.020)	(0.199)	(1.281)	(1.323)	(1.569)
Pigeon peas	0.013	1.546	0.000	0.000	0.027	1.741*	0.000
	(0.013)	(1.093)	(.)	(.)	(0.900)	(0.933)	(1.102)
Other seeds	21.956	1.517	68.275	2.803	18.452	-0.382	90.998***
	(4.066)	(0.542)	(43.165)	(0.754)	(23.457)	(24.470)	(28.777)
Chemical fertilizer	708.197	200.490	529.416	283.515	354.782***	-154.404**	205.923***
	(40.525)	(30.449)	(38.896)	(28.002)	(59.925)	(62.388)	(73.518)
Organic fertilizer	29.524	3.618	184.172	3.216	26.626	0.639	134.349***
	(6.772)	(1.331)	(32.935)	(1.272)	(18.123)	(18.821)	(22.234)
Pesticides & herbicides	77.996	1.354	48.569	21.090	28.230**	-27.157**	38.151**
	(15.626)	(0.346)	(6.876)	(2.770)	(13.295)	(13.808)	(16.311)
Hired crop labour	107.176	30.930	145.575	68.619	46.358	-37.699	13.122
	(12.788)	(5.643)	(35.646)	(15.966)	(37.733)	(39.188)	(46.292)
Land rental	42.346	16.279	8.262	3.577	74.454***	20.124	9.484
	(23.837)	(6.512)	(5.577)	(1.071)	(25.251)	(26.225)	(30.979)
Transport	227.438	1,045.062	111.942	45.967	193.606	580.781**	70.696
	(133.165)	(264.982)	(27.043)	(6.389)	(237.971)	(247.146)	(291.950)
Total input value	1 504.423	1 421.330	1 415.258	533.398	905.077***	427.100	689.475**
	(152.630)	(262.376)	(124.098)	(41.660)	(268.340)	(278.512)	(329.211)

Note: * 0.1 ** 0.05 ***0.01. Columns 1 to 4 show the post-treatment unconditional averages of the outcome variables. Columns 5 to 7 show, respectively, the average effect of the CASU alone, the HGSF alone and of the combined treatments.

Another aspect that helps us to understand the degree to which households act as self-subsistence farming units, internalizing parts of the farm production process instead of acquiring the inputs through market transactions, is the share of the harvest that is set aside as seeds. For instance, 65 percent of beans production and all of the groundnut production is set aside in the HGSF group (Table 28). However, only between 1 and 5 percent of maize is set aside in the three treatment groups. For the other crops, only marginal amounts are set aside. Both CASU and HGSF are associated with reduced storing of sorghum, while their combination is associated with greater savings of sunflower.

Table 28: Share of harvested crops set aside

	CASU	HGSF	Both	Control	CASUvsCtrl	HGSFvsCtrl	BothvsCtrl
Beans	0.022	0.650	0.018	0.081	-0.059	0.244	-0.067
	(0.006)	(0.233)	(0.004)	(0.010)	(0.210)	(0.218)	(0.260)
Cowpeas	0.026	0.002	0.003	0.001	0.019***	0.001	0.002
	(0.005)	(0.001)	(0.001)	(0.001)	(0.003)	(0.004)	(0.004)
Maize	0.014	0.027	0.049	0.178	-0.171*	-0.171*	-0.139
	(0.002)	(0.005)	(0.012)	(0.071)	(0.088)	(0.093)	(0.108)
Cassava	0.000	0.015	0.000	0.043	-0.034	-0.023	-0.034
	(.)	(0.006)	(.)	(0.032)	(0.042)	(0.051)	(0.052)
Groundnuts	0.059	1.000	0.094	0.552	-0.329	0.958	-0.288
	(0.005)	(0.911)	(0.011)	(0.529)	(0.845)	(0.903)	(1.044)
Millet	0.000	0.035	0.000	0.103	-0.014	0.018	-0.014
	(0.000)	(0.009)	(.)	(0.085)	(0.114)	(0.123)	(0.142)
Seed cotton	0.000	0.000	0.002	0.000	0.000	0.000	0.002**
	(.)	(.)	(0.002)	(.)	(0.001)	(0.001)	(0.001)
Sorghum	0.002	0.000	0.001	0.015	-0.012***	-0.012***	-0.007
	(0.001)	(.)	(0.001)	(0.003)	(0.004)	(0.004)	(0.005)
Sugar cane	0.000	0.000	0.001	0.000	0.001*	0.000	0.001*
	(0.000)	(.)	(0.001)	(.)	(0.000)	(0.000)	(0.000)
Soybeans	0.060	0.003	0.042	0.004	0.043	-0.005	0.038
	(0.034)	(0.002)	(0.009)	(0.002)	(0.033)	(0.035)	(0.040)
Sunflowers	0.008	0.000	0.031	0.000	0.008***	0.000	0.034***
	(0.002)	(.)	(0.004)	(.)	(0.003)	(0.003)	(0.004)
Potatoes	0.001	0.000	0.000	0.000	0.000	-0.000	0.000
	(0.000)	(0.000)	(.)	(.)	(0.000)	(0.000)	(0.000)
Sweet potatoes	0.010	0.002	0.003	0.002	0.007*	0.002	0.001
	(0.004)	(0.002)	(0.002)	(0.001)	(0.003)	(0.004)	(0.004)
Other	0.001	0.000	0.003	0.001	0.000	-0.001	0.004**
	(0.000)	(.)	(0.002)	(0.000)	(0.001)	(0.001)	(0.002)

Note: * 0.1 ** 0.05 ***0.01. Columns 1 to 4 show the post-treatment unconditional averages of the outcome variables. Columns 5 to 7 show, respectively, the average effect of the CASU alone, the HGSF alone and of the combined treatments.

Tables 29 and 30 repeat the analysis for livestock inputs. In Table 29, we show results for the share of farmers purchasing certain inputs on the market. Despite the high spread of livestock, only a small share of farmers use fodder or manufactured feed. The use of veterinary services and hired labour for livestock herding are more common in the population. Considering the higher share of livestock ownership among farmers in the CASU group and in the combined group, there is also a higher prevalence of the use of veterinary services and of hired labour in those same groups. The CASU and combined treatments are associated with an increase in the use of almost all livestock inputs, while HGSF has no impacts on this farm production domain.

Table 29: Share of farmers purchasing variable livestock inputs

	CASU	HGSF	Both	Control	CASUvsCtrl	HGSFvsCtrl	BothvsCtrl
Fodder	0.003	0.003	0.002	0.000	0.005**	0.002	0.000
	(0.002)	(0.002)	(0.002)	(.)	(0.002)	(0.002)	(0.003)
Manufactured feed	0.027	0.001	0.039	0.003	0.022***	-0.001	0.075***
	(0.006)	(0.001)	(0.009)	(0.002)	(0.007)	(0.007)	(0.009)
Veterinary services	0.105	0.014	0.249	0.015	0.098***	-0.011	0.230***
	(0.011)	(0.004)	(0.020)	(0.003)	(0.015)	(0.015)	(0.018)
Water	0.005	0.000	0.006	0.004	0.001	-0.002	-0.001
	(0.003)	(.)	(0.004)	(0.002)	(0.004)	(0.004)	(0.005)
Hired labour for livestock	0.073	0.036	0.105	0.015	0.035***	0.010	0.092***
	(0.009)	(0.007)	(0.014)	(0.003)	(0.013)	(0.013)	(0.016)

Note: * 0.1 ** 0.05 ***0.01. Columns 1 to 4 show the post-treatment unconditional averages of the outcome variables. Columns 5 to 7 show, respectively, the average effect of the CASU alone, the HGSF alone and of the combined treatments.

Table 30 has results for the expenditure on livestock inputs obtained through market purchases. Spending on veterinary services and on hired labour are the most important categories, although figures are low in absolute terms. Total expenditure for purchases of livestock inputs is just 6.5 percent of expenditure for crop inputs in the CASU group and 7.5 percent of expenditure for crop inputs in the HGSF group. CASU has positive impacts on the use of almost all livestock inputs, while the combined treatment only increases the use of manufactured feed. HGSF has no significant impacts.

Table 30: Expenditure on variable livestock inputs

	CASU	HGSF	Both	Control	CASUvsCtrl	HGSFvsCtrl	BothvsCtrl
Fodder	4.088	0.065	0.404	0.000	12.324***	0.000	0.000
	(4.022)	(0.065)	(0.404)	(.)	(4.287)	(4.451)	(5.261)
Manufactured feed	16.737	0.492	17.675	0.675	18.410***	0.128	18.384**
	(6.562)	(0.492)	(6.968)	(0.393)	(6.515)	(6.745)	(8.006)
Veterinary services	39.017	0.348	29.119	4.776	41.312***	-10.710	11.218
	(6.814)	(0.148)	(6.744)	(1.904)	(7.167)	(7.309)	(9.248)
Water	2.095	0.000	0.007	0.134	-9.261***	-0.164	-0.143
	(1.910)	(.)	(0.007)	(0.076)	(2.554)	(2.513)	(3.977)
Hired labour for livestock	41.710	17.649	40.805	17.175	6.240	-6.746	-28.875
	(10.609)	(4.905)	(10.073)	(6.440)	(14.137)	(14.664)	(18.371)
Total livestock input expenditure	98.334	17.028	79.111	21.205	66.945***	-17.453	-0.506
	(16.681)	(4.530)	(14.787)	(6.320)	(19.509)	(20.248)	(23.934)

Note: * 0.1 ** 0.05 ***0.01. Columns 1 to 4 show the post-treatment unconditional averages of the outcome variables. Columns 5 to 7 show, respectively, the average effect of the CASU alone, the HGSF alone and of the combined treatments.

Table 31 focuses on the value of livestock inputs obtained through free transfers or produced in-house. We note that most of the value of each input does not come from market purchases. In fact, comparing expenditures for livestock input purchases (last row in Table 30) and the value of livestock input not purchased on the market (last row in Table 31) we see that only 44 percent of the total value of livestock inputs is purchased on the market in the CASU group, and only 30 percent in the HGSF group. The degree of interaction with the input market is also relatively low in the livestock sector. In terms of impacts, the CASU treatment leads to an increased use of home-produced fodder and of manufactured feed obtained through transfers. The other two treatments have no impacts on this domain.

Table 31: Value of home-produced variable livestock inputs

	CASU	HGSF	Both	Control	CASUvsCtrl	HGSFvsCtrl	BothvsCtrl
Fodder	11.739	1.841	2.543	2.617	22.127***	0.961	4.242
	(5.699)	(0.889)	(1.414)	(1.294)	(5.754)	(5.976)	(7.059)
Manufactured feed	7.319	1.253	10.708	0.127	12.144***	1.455	7.958
	(3.357)	(0.749)	(5.189)	(0.092)	(4.047)	(4.203)	(4.965)
Veterinary services	46.365	1.815	34.807	4.082	26.285*	-3.392	17.861
	(21.546)	(0.599)	(6.288)	(1.541)	(14.532)	(15.092)	(17.828)
Water	12.150	3.718	15.895	20.113	-12.415	-27.101	-8.225
	(4.108)	(1.957)	(3.431)	(17.822)	(26.653)	(27.680)	(32.698)
Hired labour for livestock	48.571	32.465	134.828	17.395	17.245	-2.276	61.545
	(9.546)	(6.497)	(35.485)	(4.465)	(31.518)	(32.730)	(38.715)
Value of livestock inputs	125.688	39.315	197.777	42.243	65.420	-30.350	83.315
	(26.366)	(7.038)	(37.804)	(17.646)	(45.631)	(47.361)	(55.983)

Note: * 0.1 ** 0.05 ***0.01. Columns 1 to 4 show the post-treatment unconditional averages of the outcome variables. Columns 5 to 7 show, respectively, the average effect of the CASU alone, the HGSF alone and of the combined treatments.

Table 32 looks at the purchases of certain asset services, consisting mainly of the renting of mechanized agricultural tools. The renting of tractors and cultivators for land preparation is more common in the CASU group, which is unexpected, considering that CA promotes minimum soil disturbance and zero tillage. However, only 2.7 percent of CASU farmers rent tractors, while there is virtually no renting of tractors in the other groups. Renting pack or traction animals seems much more common than renting tractors in all groups. In terms of impacts, CASU is associated with increased renting of agricultural tool and animals, while the other two do not significantly impact these outcomes.

Table 32: Share of farmers purchasing asset services

	CASU	HGSF	Both	Control	CASUvsCtrl	HGSFvsCtrl	BothvsCtrl
Tractor	0.027	0.000	0.002	0.006	0.017***	-0.006	-0.004
	(0.006)	(.)	(0.002)	(0.002)	(0.006)	(0.006)	(0.007)
Cultivator	0.010	0.001	0.013	0.004	-0.001	-0.007	0.001
	(0.004)	(0.001)	(0.005)	(0.002)	(0.005)	(0.005)	(0.006)
Planter	0.001	0.000	0.000	0.001	-0.001	-0.000	-0.000
	(0.001)	(.)	(.)	(0.001)	(0.002)	(0.002)	(0.002)
Hired animals	0.084	0.000	0.026	0.028	0.057***	-0.020*	0.013
	(0.010)	(.)	(0.007)	(0.005)	(0.011)	(0.011)	(0.013)
Scotch cart	0.092	0.000	0.127	0.032	0.042***	-0.026*	0.104***
	(0.010)	(.)	(0.015)	(0.005)	(0.013)	(0.014)	(0.016)
Other assets	0.000	0.018	0.013	0.014	-0.016**	0.008	-0.002
	(.)	(0.005)	(0.005)	(0.003)	(0.007)	(0.007)	(0.009)

Note: * 0.1 ** 0.05 ***0.01. Columns 1 to 4 show the post-treatment unconditional averages of the outcome variables. Columns 5 to 7 show, respectively, the average effect of the CASU alone, the HGSF alone and of the combined treatments.

Table 33 shows results for the expenditure incurred by farmers for renting of assets. The total amount of expenditure for renting of tools (last row) is relatively low, indicating a low capital content of farm production in the sample. The CASU programme has a positive impact on total expenditure for renting tools while the other two arms have no significant impacts.

Table 33: Expenditure on services for farming

	CASU	HGSF	Both	Control	CASUvsCtrl	HGSFvsCtrl	BothvsCtrl
Tractor	25.061	0.000	1.724	4.425	7.043	-4.277	-3.189
	(7.709)	(.)	(1.724)	(2.154)	(6.497)	(6.631)	(7.835)
Hired animals	37.466	0.000	3.866	12.475	29.804***	-3.226	0.857
	(5.938)	(.)	(1.367)	(3.175)	(6.235)	(6.271)	(7.667)
Scotch cart	40.709	0.000	43.357	10.148	14.893	-12.560	36.360***
	(9.897)	(.)	(17.658)	(3.645)	(10.617)	(10.087)	(13.987)
Other assets	0.000	2.321	1.158	1.101	-1.371	1.485	-0.216
	(.)	(0.774)	(0.725)	(0.352)	(0.875)	(0.927)	(1.088)
Total expenditure on asset services	91.919	2.577	43.101	29.457	38.023***	-20.980	18.931
	(11.933)	(0.851)	(13.104)	(5.423)	(13.145)	(13.644)	(16.127)

Note: * 0.1 ** 0.05 ***0.01. Columns 1 to 4 show the post-treatment unconditional averages of the outcome variables. Columns 5 to 7 show, respectively, the average effect of the CASU alone, the HGSF alone and of the combined treatments.

To sum up, the CASU programme is associated with increased input market participation by beneficiary farmers in terms of both the share of those buying an input or service and the amounts spent. At the same time, CASU is also associated with increases of inputs that are home-produced or received for free, in both the crop and livestock sectors. The HGSF programme is associated with reduced market engagement for crop inputs but has no influence on livestock inputs or the use of services such as hiring of mechanized tools. HGSF has little impact in terms of home-produced inputs and inputs received through non-market channels.

Conservation agriculture and technology adoption

In this section we look at the use of CA practices. For each crop, farmers were asked whether they applied any CA at all. In another section of the questionnaire, we asked farmers whether they used a specific CA practice on any crop. Table 34 shows results for the share of farmers using any CA at all, by crop. Around 70 percent of CASU beans growers adopt CA practices, while only 18 percent of HGSF beans growers adopt CA practices. In general, adoption rates of CA practices range between 42 and 80 percent for CASU farmers and between 4 and 55.7 percent for HGSF farmers. CA is most commonly applied for seed cotton and sunflowers by HGSF farmers. For farmers under the combined treatment, CA adoption rates are generally high and similar to those of the CASU group for most crops. The CASU and its combination with the HGSF are associated with increased use of CA practices for virtually all crops. The HGSF is associated mainly with reductions of CA adoption, especially for cowpeas and maize.

Table 34: Share of farmers using CA by crop

	CASU	HGSF	Both	Control	CASUvsCtrl	HGSFvsCtrl	BothvsCtrl
Beans	0.700	0.181	0.700	0.148	0.664***	0.035	0.416***
	(0.040)	(0.015)	(0.060)	(0.018)	(0.051)	(0.031)	(0.080)
Cowpeas	0.805	0.143	0.917	0.300	0.010	-0.783**	0.206
	(0.037)	(0.143)	(0.058)	(0.153)	(0.373)	(0.370)	(0.389)
Maize	0.802	0.225	0.840	0.327	0.453***	-0.117***	0.524***
	(0.015)	(0.018)	(0.017)	(0.014)	(0.027)	(0.030)	(0.033)
Cassava	0.556	0.196	0.333	0.074	0.963***	0.181***	0.066
	(0.176)	(0.027)	(0.211)	(0.027)	(0.300)	(0.066)	(0.353)
Groundnuts	0.660	0.141	0.583	0.221	0.393***	-0.080	0.344***
	(0.025)	(0.020)	(0.031)	(0.028)	(0.052)	(0.055)	(0.057)
Millet	0.084	0.101			-0.132**	0.022	-0.132**
	(0.031)	(0.034)			(0.057)	(0.075)	(0.057)
Seed cotton	0.611	0.576	0.429		1.494*	0.758	1.233
	(0.067)	(0.061)	(0.202)		(0.881)	(0.873)	(0.877)
Sorghum	0.500	0.100	0.028		-0.010	-0.010	-0.010
	(0.289)	(.)	(0.020)		(0.027)	(0.027)	(0.027)
Rice	0.750				0.000	0.000	0.000
	(0.250)				(.)	(.)	(.)
Soybeans	0.712	0.125	0.687	0.361	0.427***	-0.582	0.337***
	(0.043)	(0.125)	(0.030)	(0.081)	(0.136)	(0.818)	(0.128)
Tobacco	0.800				0.000	0.000	0.000
	(0.200)				(.)	(.)	(.)
Sunflower	0.646	0.542	0.750		0.720***	0.000	0.531***
	(0.070)	(0.038)	(0.250)		(0.130)	(.)	(0.050)
Potatoes	0.500	0.333	0.250		0.000	0.000	0.000
	(0.289)	(0.211)	(0.164)		(.)	(.)	(.)
Sweet potatoes	0.425	0.045	0.340	0.114	0.287***	-0.034	0.179
	(0.036)	(0.032)	(0.070)	(0.038)	(0.088)	(0.158)	(0.120)
Other	0.586	0.000	0.714	0.281	0.111	-0.394***	0.273
	(0.093)	(.)	(0.184)	(0.081)	(0.184)	(0.117)	(0.378)

Note: * 0.1 ** 0.05 ***0.01. Columns 1 to 4 show the post-treatment unconditional averages of the outcome variables. Columns 5 to 7 show, respectively, the average effect of the CASU alone, the HGSF alone and of the combined treatments.

Table 35 shows results for the adoption of specific CA practices regardless of the crop to which they were applied.[13] Zero tillage is adopted by 57.4 percent of CASU farmers and

[13] Zero tillage is a way of growing crops without disturbing the soil through tillage. The planting basin technology is a CA option for vulnerable households with poor or no access to animal draught power and involves making a hand hoe basin of 15cm x 15cm x 15cm. This basin technology emphasizes the water capture benefits of basins, but at the cost of significant soil disturbance and labour investment. Intercropping and crop rotations allow farmers to plant several crops in rotation or as intercrops instead of planting a single crop. Rotation of maize with legumes, for instance, is essential in maintaining and improving soil fertility and exploration of different soil layers by different crop species. Leaving the crop residue on the surface as mulch makes it hard for weeds to grow because they do not have enough space or light. The standard contour drain is designed to divert water

by 76 percent of farmers in the combined treatment group. For the other two groups zero tillage is adopted by around 15 percent of farmers. All other techniques have very high adoption rates in the CASU and the combined groups, with the latter group being sometimes more prone to adoption than the CASU-alone beneficiaries. Specific CA techniques are particularly popular among HGSF farmers, reaching a spread as high as among CASU farmers. For instance, 21.5 percent of HGSF farmers adopt intercropping compared with 35.5 percent diffusion among CASU farmers. In terms of impacts, the CASU treatment and its combination with HGSF are associated with positive impacts on the adoption rate of all CA practices, while for the HGSF group positive impacts are limited to crop rotations and mulch use.

Table 35: Share of farmers using specific CA practices

	CASU	HGSF	Both	Control	CASUvsCtrl	HGSFvsCtrl	BothvsCtrl
Zero tillage	0.574	0.161	0.760	0.145	0.415***	0.011	0.557***
	(0.018)	(0.013)	(0.020)	(0.010)	(0.026)	(0.027)	(0.031)
Planting basins	0.642	0.093	0.552	0.198	0.405***	-0.119***	0.259***
	(0.017)	(0.010)	(0.023)	(0.011)	(0.026)	(0.028)	(0.032)
Rotations	0.697	0.364	0.788	0.191	0.442***	0.176***	0.608***
	(0.017)	(0.018)	(0.019)	(0.011)	(0.027)	(0.029)	(0.033)
Intercropping	0.353	0.215	0.536	0.169	0.158***	-0.002	0.288***
	(0.017)	(0.015)	(0.023)	(0.010)	(0.027)	(0.029)	(0.033)
Leaving residues	0.762	0.302	0.730	0.306	0.397***	-0.010	0.372***
	(0.015)	(0.017)	(0.021)	(0.013)	(0.028)	(0.031)	(0.035)
Mulch	0.686	0.335	0.605	0.228	0.420***	0.106***	0.269***
	(0.017)	(0.017)	(0.023)	(0.012)	(0.028)	(0.031)	(0.035)
Draining	0.179	0.103	0.309	0.071	0.078***	-0.005	0.182***
	(0.014)	(0.011)	(0.021)	(0.007)	(0.021)	(0.022)	(0.025)
Grass barriers	0.141	0.203	0.260	0.093	0.025	0.093***	0.078***
	(0.013)	(0.015)	(0.020)	(0.008)	(0.022)	(0.024)	(0.027)
Contours	0.221	0.098	0.324	0.076	0.113***	0.035	0.230***
	(0.015)	(0.011)	(0.022)	(0.007)	(0.021)	(0.023)	(0.026)

Note: * 0.1 ** 0.05 ***0.01. Columns 1 to 4 show the post-treatment unconditional averages of the outcome variables. Columns 5 to 7 show, respectively, the average effect of the CASU alone, the HGSF alone and of the combined treatments.

In Table 36 we look at the channels through which farmers in each group have learned about CA. For CASU farmers and for those benefiting from both treatments, learning from another CASU farmer, known as the lead farmer, is the most common method for spreading CA knowledge. The other channels – namely, learning through non-CASU farmers, through extension officers or through their

from the field, while contour farming is the practice of planting across a slope following its contour lines. These contour lines create a water break which reduces the formation of water rills during times of heavy water run-off. Further, weeds growing on the field boundary create a perennial grassy margin and form a barrier to weed spread into the adjacent plot.

own initiative – are not very common among CASU and combined treatment farmers. For HGSF farmers, 44.6 percent of those adopting some CA have learned the practice through other farmers, which is the most common channel. In terms of impacts, CASU stimulates the spread of CA practices from one CASU farmer to another, while discouraging all other channels. A similar pattern, but with quantitatively stronger impacts, is observed also for the combined group. HGSF positively impacts the spread of CA knowledge through other fellow farmers while discouraging the extension channel.

Table 36: Diffusion channels of CA

	CASU	HGSF	Both	Control	CASUvsCtrl	HGSFvsCtrl	BothvsCtrl
Other CASU farmer	0.695	0.115	0.788	0.005	0.688***	0.118*	0.774***
	(0.022)	(0.028)	(0.022)	(0.005)	(0.048)	(0.066)	(0.051)
Other farmer	0.089	0.446	0.000	0.246	-0.202***	0.111**	-0.273***
	(0.014)	(0.044)	(.)	(0.031)	(0.036)	(0.049)	(0.038)
Extension	0.107	0.146	0.184	0.304	-0.194***	-0.240***	-0.151***
	(0.015)	(0.031)	(0.021)	(0.033)	(0.045)	(0.062)	(0.048)
Own initiative	0.048	0.269	0.014	0.340	-0.214***	0.063	-0.239***
	(0.010)	(0.039)	(0.006)	(0.034)	(0.037)	(0.051)	(0.039)

Note: * 0.1 ** 0.05 ***0.01. Columns 1 to 4 show the post-treatment unconditional averages of the outcome variables. Columns 5 to 7 show, respectively, the average effect of the CASU alone, the HGSF alone and of the combined treatments.

The farmers who declared that they had not adopted any CA practice were also asked about the reason for their choice. Results are shown in Table 37. The most cited reason for not adopting CA among farmers is lack of resources (41-56%), regardless of the group, followed by lack of information (37-52%). None of the three treatments had any discernible effects on the reasons for not adopting CA.

Table 37: Reasons for not adopting CA

	CASU	HGSF	Both	Control	CASUvsCtrl	HGSFvsCtrl	BothvsCtrl
Lack of information	0.397	0.400	0.525	0.375	0.214	-0.551	-0.046
	(0.065)	(0.100)	(0.080)	(0.071)	(0.160)	(0.747)	(0.198)
Too risky	0.155	0.040	0.050	0.208	-0.007	0.161	-0.132
	(0.048)	(0.040)	(0.035)	(0.059)	(0.110)	(0.512)	(0.136)
Lack of resources	0.448	0.560	0.425	0.417	-0.206	0.390	0.178
	(0.066)	(0.101)	(0.079)	(0.072)	(0.152)	(0.708)	(0.188)

Note: * 0.1 ** 0.05 ***0.01. Columns 1 to 4 show the post-treatment unconditional averages of the outcome variables. Columns 5 to 7 show, respectively, the average effect of the CASU alone, the HGSF alone and of the combined treatments.

Farmers were asked whether they were using a particular CA practice for two years in a row. Results are shown in Table 38. Generally, numbers in this Table are lower than those in Table 35, meaning that the share of farmers sticking with CA over the years is lower than the share of those adopting a CA practice in a given year. The CASU and combined treatment arms present high retention rates of CA practices, with more than half of them sticking to crop rotations from one year to the next. Retention rates are understandably much lower for farmers in the HGSF group, who have no exposure to CASU training. In terms of impacts, CASU stimulates retention of practices and so does its combination with HGSF, with even higher impacts for certain practices. HGSF alone stimulates retention of the crop rotation practice, of mulch and of grass barriers, while discouraging planting basins.

Table 38: Share of persistent CA users

	CASU	HGSF	Both	Control	CASUvsCtrl	HGSFvsCtrl	BothvsCtrl
Zero tillage	0.403	0.139	0.526	0.108	0.264***	0.019	0.334***
	(0.018)	(0.012)	(0.023)	(0.009)	(0.025)	(0.026)	(0.031)
Planting basins	0.472	0.075	0.373	0.147	0.277***	-0.079***	0.139***
	(0.018)	(0.010)	(0.022)	(0.010)	(0.025)	(0.027)	(0.031)
Rotations	0.538	0.275	0.639	0.153	0.327***	0.128***	0.510***
	(0.018)	(0.016)	(0.022)	(0.010)	(0.027)	(0.030)	(0.034)
Intercropping	0.252	0.141	0.440	0.131	0.090***	-0.019	0.257***
	(0.016)	(0.013)	(0.023)	(0.009)	(0.025)	(0.027)	(0.030)
Leaving residues	0.591	0.264	0.584	0.240	0.332***	0.040	0.292***
	(0.018)	(0.016)	(0.023)	(0.012)	(0.029)	(0.031)	(0.035)
Mulch	0.556	0.276	0.496	0.170	0.362***	0.106***	0.241***
	(0.018)	(0.016)	(0.023)	(0.010)	(0.028)	(0.030)	(0.034)
Draining	0.114	0.065	0.234	0.057	0.041**	-0.026	0.123***
	(0.012)	(0.009)	(0.020)	(0.006)	(0.018)	(0.019)	(0.022)
Grass barriers	0.081	0.166	0.197	0.071	0.002	0.091***	0.022
	(0.010)	(0.014)	(0.018)	(0.007)	(0.019)	(0.021)	(0.023)
Contours	0.163	0.066	0.260	0.064	0.073***	0.012	0.189***
	(0.013)	(0.009)	(0.020)	(0.007)	(0.019)	(0.021)	(0.024)

Note: * 0.1 ** 0.05 ***0.01. Columns 1 to 4 show the post-treatment unconditional averages of the outcome variables. Columns 5 to 7 show, respectively, the average effect of the CASU alone, the HGSF alone and of the combined treatments.

Durable assets

Durable goods are mostly an indicator of wealth and quality of life; only some of them are directly connected to the farm production process. Similarly to what we did for agricultural tools, here we look at the average of a group of variables, each of which is equal to one if the household owns the good and zero otherwise. For instance, Table 39 shows that almost half of the farmers own a bike in

all treatment groups. Possession of home electrical appliances and of mobile phones is unbalanced in favour of CASU and combined treatment farmers. Axes and hoes are almost equally distributed across the groups, while other tools, such as shovels, ploughs and spray machines, are more present in the CASU and combined groups. In terms of impacts, CASU is associated with higher asset accumulation for almost all items considered here. HGSF discourages asset accumulation, especially for TV and radio sets, mobile phones and most agricultural equipment. The combined group induces higher asset accumulation for mobile phones and big agricultural equipment, such as ploughs, spray machines and Scotch carts, while discouraging the accumulation of smaller tools such as axes and shovels.

Table 39: Share of farmers owning an asset

	CASU	HGSF	Both	Control	CASUvsCtrl	HGSFvsCtrl	BothvsCtrl
Bike	0.525	0.551	0.599	0.585	-0.136***	-0.042	-0.068*
	(0.018)	(0.018)	(0.023)	(0.014)	(0.029)	(0.030)	(0.036)
Motorcycle	0.038	0.022	0.089	0.028	0.028**	-0.009	0.050***
	(0.007)	(0.005)	(0.013)	(0.005)	(0.013)	(0.014)	(0.016)
Tractor	0.011	0.000	0.009	0.005	0.009*	-0.004	0.005
	(0.004)	(.)	(0.004)	(0.002)	(0.005)	(0.005)	(0.006)
Mobile phone	0.882	0.436	0.743	0.589	0.227***	-0.133***	0.164***
	(0.012)	(0.018)	(0.020)	(0.014)	(0.026)	(0.028)	(0.032)
Television	0.367	0.080	0.175	0.234	0.126***	-0.166***	-0.117***
	(0.018)	(0.010)	(0.018)	(0.012)	(0.024)	(0.026)	(0.030)
Radio	0.617	0.228	0.425	0.437	0.158***	-0.247***	-0.039
	(0.018)	(0.015)	(0.023)	(0.014)	(0.029)	(0.031)	(0.035)
Hoe	0.983	0.891	0.920	0.945	0.028**	-0.043***	-0.001
	(0.005)	(0.011)	(0.013)	(0.006)	(0.013)	(0.014)	(0.017)
Axe	0.925	0.895	0.832	0.884	0.009	-0.002	-0.082***
	(0.010)	(0.011)	(0.017)	(0.009)	(0.018)	(0.020)	(0.022)
Shovel	0.662	0.152	0.257	0.401	0.286***	-0.256***	-0.106***
	(0.017)	(0.013)	(0.020)	(0.014)	(0.027)	(0.029)	(0.034)
Plough	0.358	0.003	0.525	0.063	0.242***	-0.102***	0.418***
	(0.017)	(0.002)	(0.023)	(0.007)	(0.021)	(0.022)	(0.026)
Irrigation equipment	0.079	0.005	0.043	0.016	0.065***	-0.027**	0.011
	(0.010)	(0.003)	(0.009)	(0.003)	(0.011)	(0.012)	(0.014)
Crop sprayer	0.456	0.012	0.400	0.146	0.248***	-0.182***	0.221***
	(0.018)	(0.004)	(0.023)	(0.010)	(0.023)	(0.025)	(0.029)
Scotch cart	0.196	0.000	0.251	0.033	0.156***	-0.057***	0.198***
	(0.014)	(.)	(0.020)	(0.005)	(0.017)	(0.019)	(0.021)

Note: * 0.1 ** 0.05 ***0.01. Columns 1 to 4 show the post-treatment unconditional averages of the outcome variables. Columns 5 to 7 show, respectively, the average effect of the CASU alone, the HGSF alone and of the combined treatments.

Table 40 looks at the average number of tools per household for those who do own at least one. For instance, those CASU households that own a bike (52.5 percent from Table 39) have one bike each, on average. The other groups also own one bike each, on average. The number of mobile phones owned is around two for CASU and combined treatment farmers. HGSF farmers own one mobile phone per household, on average. Households own between three and six hoes each and one plough, one spray machine and one shovel each. In terms of impacts, the CASU programme alone and in combination stimulates investment in bikes and hoes, while HGSF discourages investments in bikes, mobile phones, hoes, ploughs and spray machines.

Table 40: Number of tools and assets

	CASU	HGSF	Both	Control	CASUvsCtrl	HGSFvsCtrl	BothvsCtrl
Bike	1.376	1.148	1.283	1.250	0.088**	-0.106**	0.087*
	(0.032)	(0.021)	(0.039)	(0.020)	(0.044)	(0.044)	(0.052)
Motorcycle	1.138	0.706	1.244	0.972	0.236	-0.123	0.235
	(0.096)	(0.114)	(0.084)	(0.063)	(0.176)	(0.451)	(0.199)
Mobile phone	2.196	1.370	1.712	1.737	0.258	-0.350*	-0.155
	(0.134)	(0.038)	(0.062)	(0.045)	(0.163)	(0.211)	(0.204)
Television	1.140	1.082	1.160	1.125	0.019	0.052	0.060
	(0.025)	(0.048)	(0.045)	(0.023)	(0.044)	(0.080)	(0.073)
Radio	1.304	1.064	1.365	1.100	0.211	0.016	0.272
	(0.139)	(0.025)	(0.225)	(0.018)	(0.155)	(0.236)	(0.218)
Hoe	5.640	3.393	5.979	4.360	0.981***	-0.928***	0.958***
	(0.103)	(0.074)	(0.141)	(0.078)	(0.150)	(0.165)	(0.186)
Axe	1.930	2.027	1.831	1.903	-0.102	0.207	-0.140
	(0.043)	(0.097)	(0.108)	(0.064)	(0.128)	(0.137)	(0.162)
Shovel	1.445	1.088	1.739	1.597	-0.070	-0.409	0.266
	(0.038)	(0.044)	(0.538)	(0.179)	(0.239)	(0.414)	(0.394)
Plough	1.369	1.000	1.239	1.341	-0.081	-1.290***	-0.108
	(0.048)	(.)	(0.041)	(0.074)	(0.127)	(0.113)	(0.127)
Crop sprayer	1.267	1.000	1.238	1.211	0.096	-1.119***	0.117
	(0.035)	(.)	(0.041)	(0.040)	(0.077)	(0.061)	(0.089)
Scotch cart	1.007	1.009	1.070		-0.173***	-1.176***	-0.170***
	(0.007)	(0.009)	(0.039)		(0.035)	(0.032)	(0.036)

Note: * 0.1 ** 0.05 ***0.01. Columns 1 to 4 show the post-treatment unconditional averages of the outcome variables. Columns 5 to 7 show, respectively, the average effect of the CASU alone, the HGSF alone and of the combined treatments.

Credit, debt and savings

Due to missing or incomplete markets, credit and liquidity constraints are often impediments in many rural parts of Africa (Triki and Faye, 2013). This translates into forgone investment opportunities and suboptimal allocation of resources, which is one of the leading causes of poverty traps. We interpret our results as follows. An increase in savings should be an indication of

improvement and greater resilience. On the other hand, buying more on credit and getting more indebted could be a symptom of growing exposure and vulnerability (lack of cash). However, an increase in long-term debt may point to a belief by the lender in the debtor's solvency and capacity to repay.

Table 41 shows descriptive statistics and impacts for the share of households that save, have obtained consumption loans by buying on credit in local shops or have borrowed money for a longer period. Purchases on credit at local petty trade shops is common in the sample, with one every five households declaring to have used this type of credit. The share of HGSF farmers buying on credit has more than doubled (14.5 percentage points increase) compared with the control, yet they owe less. This may suggest they are very liquidity-constrained and need credit for even very small purchases. The amounts owed are similar, around ZMK 100 per household, except for the combined group, whose members owe ZMK 190 on average. Between 8 and 15 percent of the households owe some money for longer periods. The average amounts of outstanding debt are considerably higher for the CASU and the combined treatment farmers, between ZMK 500 and 600, while HGSF farmers owe ZMK 162 on average. More CASU farmers are able to save during the year (40%), while only around 25 percent of farmers manage to save part of their income in the other groups. In terms of impacts, the CASU programme stimulates savings but also leads to increased purchases on credit and longer-term borrowing. HGSF is also associated with increased purchases on credit. Fewer CASU beneficiaries buy on credit, but they get larger loans, while the opposite is true of HGSF households, which could be an indication of their dissimilar perceived capacity to repay.

Table 41: Credit, debt and savings

	CASU	HGSF	Both	Control	CASUvsCtrl	HGSFvsCtrl	BothvsCtrl
HH saves (share)	0.409	0.242	0.258	0.256	0.174***	0.018	0.012
	(0.018)	(0.015)	(0.020)	(0.012)	(0.028)	(0.029)	(0.034)
Amount saved (ZMK)	1 663.982	1 135.969	1 280.808	1 211.601	170.339	-217.626	128.277
	(112.753)	(100.068)	(150.726)	(93.255)	(191.547)	(233.204)	(260.203)
Buys on credit (share)	0.184	0.223	0.174	0.132	0.059**	0.145***	0.056**
	(0.014)	(0.015)	(0.018)	(0.009)	(0.023)	(0.024)	(0.028)
Amount owed (ZMK)	102.855	80.758	189.481	120.184	-37.927	-87.928**	8.188
	(28.686)	(10.860)	(43.685)	(16.395)	(42.960)	(40.586)	(51.001)
Owes debts (share)	0.157	0.079	0.099	0.093	0.055***	-0.024	-0.001
	(0.013)	(0.010)	(0.014)	(0.008)	(0.019)	(0.020)	(0.023)
Outstanding debt (ZMK)	688.737	162.656	487.000	508.553	227.203	-341.393	154.366
	(98.907)	(28.813)	(100.973)	(99.416)	(170.744)	(238.781)	(257.294)

Note: * 0.1 ** 0.05 ***0.01. Columns 1 to 4 show the post-treatment unconditional averages of the outcome variables. Columns 5 to 7 show, respectively, the average effect of the CASU alone, the HGSF alone and of the combined treatments.

5.3.Food and nutrition security

In this section, we analyse the impacts of the programmes on household FNS. Until now we have considered the HGSF as one programme when analysing its effects on farm production, although we do not expect the school meals to have any big influence on the production side. When analysing schooling and FNS aspects, both the meals and the P4P local purchases for HGSF may have sizable impacts on these outcomes. In particular, meals are expected to have a direct impact on FNS and schooling outcomes, while the purchases from HGSF farmers would have indirect effects through their influence on household income. Therefore, we believe it is of interest to study the impacts of the school meals separately from those of the local purchases from farmers enrolled in the HGSF programme. Despite the fact that the study was not designed to disentangle such effects, we can still address them by limiting the sample to HGSF-only farmers and using a self-declared dummy variable that records whether a household is sending any children to a school that provides school meals. In this way, we are limiting the sample to households that benefit from the P4P purchases, only some of whom are sending their children to schools under the school meals programme. There can be several reasons why a household declares not to be sending its children to a school with meals: the respondent may be not aware of the existence of the meals at the school attended by her children; the household does not have children in the age range covered by the programme; the household sends the children to a school not under the meals programme – although, in theory, all primary and pre-primary public schools in a district are covered by the programme. Whatever the reason, we conducted a comparison analysis between HGSF-only households that declare to benefit from school meals and those that declare not to benefit. The two samples do not differ in significant ways in terms of most of the observed variables considered in the analysis. Besides this ad hoc analysis, we also present results for FNS and schooling outcomes in the same format we have been using previously – i.e. for HGSF as a whole, for CASU and for the combination of CASU and HGSF.

Effects of school meals on dietary diversity for children

Dietary diversity is a qualitative measure of food consumption that reflects household access to a variety of foods and is also a proxy for nutrient adequacy of the diet of individuals (FAO, 2011). The children's dietary diversity score (CDDS) consists of a simple count of food groups that a child has consumed over the preceding 24 hours. There are nine food groups formed by aggregating the answers on sixteen specific foods, namely: cereals; white roots and tubers; orange roots and tubers; dark green vegetables; other vegetables; orange fruits; other fruits; organ meat; flesh meat; eggs; fish; legumes; milk; oil; sweets; and spices. Hence, the potential score range is 0-9. There are no established cut-off points in terms of number of food groups to indicate adequate or inadequate dietary diversity for the CDDS. Table 42 shows impacts of the school meals on CDDS. We notice that the sample average of the CDDS is 1.8, which is low, considering the possible range of the indicator. Table 42 also shows that school meals have a positive impact on child dietary diversity, leading to an increase of 60 percent of the score.

Table 42: Impact of school meals on children's dietary diversity

	Average	Impact
CDDS	1.842	1.134***
	(0.084)	(0.193)

Note: * 0.1 ** 0.05 ***0.01. Column 1 shows the post-treatment unconditional averages of the outcome variables in the HGSF-only group. Column 2 shows the impact. Standard errors are shown in parentheses.

We now analyse the reasons behind the improvement of the aggregate score, by looking at the effects of the school meals on the consumption of specific foods. Table 43 shows that the most widely spread food items are dark green vegetables, cereals, non-orange fruits, eggs and legumes. In terms of impacts, the school meals lead to an increase in the consumption of vegetables, both dark green and other, non-orange fruits, eggs and fish. The main ingredients of the school meal – namely, cereals and legumes – are left unaffected. One possible reason for this may be that the respondent is unaware of what the children actually eat at school and may base their answers on children's observed behaviour at home. Children may prefer to consume different food items at home from those consumed at school.

Table 43: Children's dietary diversity components

	Average	Impact
Cereals	0.502	0.065
	(0.025)	(0.065)
White roots & tubers	0.236	0.102*
	(0.021)	(0.055)
Orange roots & tubers	0.187	0.075
	(0.019)	(0.052)
Dark green vegetables	0.636	0.209***
	(0.024)	(0.061)
Other vegetables	0.626	0.206***
	(0.024)	(0.062)
Orange fruits	0.189	0.036
	(0.020)	(0.052)
Other fruits	0.501	0.215***
	(0.025)	(0.064)
Organ meat	0.109	-0.002
	(0.016)	(0.041)
Flesh meat	0.285	0.124**
	(0.023)	(0.060)
Eggs	0.504	0.219***
	(0.025)	(0.065)
Fish	0.434	0.169***
	(0.025)	(0.065)
Legumes, nuts & seeds	0.285	0.094
	(0.023)	(0.059)
Milk & milk products	0.089	0.111***
	(0.014)	(0.037)
Oil & fats	0.650	0.114*
	(0.024)	(0.062)
Sweets	0.377	0.137**
	(0.024)	(0.063)
Spices	0.099	0.090**
	(0.015)	(0.039)

Note: * 0.1 ** 0.05 ***0.01. Column 1 shows the post-treatment unconditional averages of the outcome variables in the HGSF-only group. Column 2 shows the impact. Standard errors are shown in parentheses.

We now look at the minimum dietary diversity indicator for women (MDD-W) (FAO, 2011). Women aged 15-49 were asked whether they have consumed one of the above-mentioned foods. Ten food groups are formed by aggregating the original sixteen foods.[14] The MDD-W is a dichotomous indicator of whether or not women 15-49 years of age have consumed at least five out of ten defined food groups in the previous 24 hours. The proportion of women 15-49 years of age who reach this minimum in a population can be used as a proxy indicator for higher micronutrient adequacy. We also look at the effects on the women's dietary diversity score (WDDS), which is defined in a similar fashion to the CDDS. Table 44 has results for both indicators. The school meals are not supposed to directly affect the diet adequacy of women, but they may lead to more food being available at home for other family members, since children eat one meal at school. The MDD-W shows that one in every four women has a sufficiently adequate diet and that the meals improve dietary diversity.[15]

Table 44: Impact of school meals on women's dietary diversity

	Average	Impact
WDDS	2.431	0.581***
	(0.091)	(0.219)
MDD-W	0.245	0.085**
	(0.015)	(0.037)

Note: * 0.1 ** 0.05 ***0.01. Column 1 shows the post-treatment unconditional averages of the outcome variables in the HGSF-only group. Column 2 shows the impact. Standard errors are shown in parentheses.

Children's dietary diversity

We now go back to analysing the impacts of our three treatments – namely, CASU alone, CASU in combination with HGSF and HGSF alone. Table 45 shows the impacts of each of these treatments on the CDDS. CASU can influence the CDDS only indirectly, through an income or time allocation channel. HGSF can influence the CDDS both directly through the provision of school meals and indirectly through the impacts of the programme's market access component on the household's income and time allocation decisions. The effects of the combined CASU and HGSF programmes work through a combination of all these direct and indirect channels. HGSF has a negative impact on the CDDS. This contrasts with the positive impact of the meals alone on the same indicator, pointing to a possible detrimental impact of the public food procurement component. CASU and its combination with the HGSF strongly improve the children's dietary diversity situation.

[14] Compared to CDDS, MDD-W score aggregates the original food items differently, due to different needs in terms of nutritional intakes.

[15] The WDDS sample average does not have a clear meaning, since it is hard to interpret a raw score without introducing a metric. However, since the raw score satisfies the monotonicity property (the scores always increase as the person's dietary diversity increases), we can interpret the positive impact as an improvement of women's dietary diversity situation.

Table 45: Children's dietary diversity score

	CASU	HGSF	Both	Control	CASUvsCtrl	HGSFvsCtrl	BothvsCtrl
CDDS	3.459	1.842	3.266	2.523	0.313*	-0.791***	0.647***
	(0.114)	(0.084)	(0.141)	(0.079)	(0.167)	(0.173)	(0.204)

Note: * 0.1 ** 0.05 ***0.01. Columns 1 to 4 show the post-treatment unconditional averages of the outcome variables. Columns 5 to 7 show, respectively, the average effect of the CASU alone, the HGSF alone and of the combined treatments.

We now look into the effects of each of the programmes on the sixteen specific food items that compose the CDDS (Table 46). We note that CASU is associated with increased consumption of cereals, dark green vegetables, orange fruits, flesh meats and milk. HGSF is associated with decreased consumption of cereals and legumes and milk. The combination of CASU and HGSF leads to lower consumption of cereals and fish and more of orange roots and fruits, meat and legumes. We will discuss the possible reasons for these results in the conclusion and discussion section in light of our predictions from the theory of change.

Table 46: Children's dietary diversity components

	CASU	HGSF	Both	Control	CASUvsCtrl	HGSFvsCtrl	BothvsCtrl
Cereals	0.932	0.502	0.518	0.752	0.133***	-0.225***	-0.218***
	(0.011)	(0.025)	(0.028)	(0.016)	(0.034)	(0.036)	(0.040)
White roots & tubers	0.303	0.236	0.307	0.312	0.056	0.015	0.010
	(0.020)	(0.021)	(0.026)	(0.017)	(0.038)	(0.039)	(0.044)
Orange roots & tubers	0.260	0.187	0.353	0.268	0.032	0.002	0.119***
	(0.019)	(0.019)	(0.027)	(0.016)	(0.036)	(0.038)	(0.043)
Dark green vegetables	0.924	0.636	0.672	0.705	0.255***	-0.032	0.014
	(0.012)	(0.024)	(0.026)	(0.017)	(0.035)	(0.037)	(0.041)
Other vegetables	0.656	0.626	0.672	0.701	-0.047	-0.025	0.027
	(0.021)	(0.024)	(0.026)	(0.017)	(0.039)	(0.041)	(0.046)
Orange fruits	0.295	0.189	0.328	0.238	0.089**	-0.021	0.110***
	(0.020)	(0.020)	(0.026)	(0.016)	(0.036)	(0.038)	(0.042)
Other fruits	0.356	0.501	0.457	0.458	-0.095**	0.055	0.093*
	(0.021)	(0.025)	(0.028)	(0.018)	(0.041)	(0.044)	(0.048)
Organ meat	0.254	0.109	0.248	0.193	0.033	-0.043	0.145***
	(0.019)	(0.016)	(0.024)	(0.014)	(0.032)	(0.034)	(0.038)
Flesh meat	0.474	0.285	0.531	0.355	0.149***	-0.024	0.223***
	(0.022)	(0.023)	(0.028)	(0.017)	(0.040)	(0.043)	(0.047)
Eggs	0.487	0.504	0.497	0.485	0.031	0.039	0.042
	(0.022)	(0.025)	(0.028)	(0.018)	(0.042)	(0.044)	(0.049)
Fish	0.521	0.434	0.224	0.471	0.038	-0.071*	-0.325***
	(0.022)	(0.025)	(0.023)	(0.018)	(0.040)	(0.043)	(0.047)
Legumes, nuts & seeds	0.429	0.285	0.534	0.375	0.063	-0.109**	0.171***
	(0.022)	(0.023)	(0.028)	(0.018)	(0.040)	(0.043)	(0.047)
Milk & milk products	0.411	0.089	0.359	0.228	0.172***	-0.187***	0.160***
	(0.022)	(0.014)	(0.027)	(0.015)	(0.035)	(0.038)	(0.042)
Oil & fats	0.845	0.650	0.647	0.795	0.024	-0.149***	-0.158***
	(0.016)	(0.024)	(0.027)	(0.015)	(0.034)	(0.037)	(0.040)
Sweets	0.444	0.377	0.301	0.357	0.020	0.010	-0.036
	(0.022)	(0.024)	(0.025)	(0.017)	(0.040)	(0.042)	(0.046)
Spices	0.425	0.099	0.153	0.207	0.171***	-0.085**	-0.053
	(0.022)	(0.015)	(0.020)	(0.015)	(0.033)	(0.035)	(0.039)

Note: * 0.1 ** 0.05 ***0.01. Columns 1 to 4 show the post-treatment unconditional averages of the outcome variables. Columns 5 to 7 show, respectively, the average effect of the CASU alone, the HGSF alone and of the combined treatments.

Women's dietary diversity

In this subsection we repeat the analysis for women's dietary diversity. Table 47 shows sample averages and impacts on the MDD-W indicator and on the WDDS. CASU and its combination with HGSF are associated with improvements in the WDDS, while HGSF alone reduces the WDDS. The MDD-W provides consistent information, pointing to a lower share of women who have an adequate intake of micronutrients in the HGSF group (24.5%) relative to the rest of the sample. In terms of impacts, only the combination of CASU with HGSF has a significant influence on this indicator, leading to an increase in the share of women with micronutrient adequacy.

Table 47: Women's dietary diversity

	CASU	HGSF	Both	Control	CASUvsCtrl	HGSFvsCtrl	BothvsCtrl
WDDS	3.099	2.431	4.071	3.029	0.310*	-0.587***	1.196***
	(0.111)	(0.091)	(0.131)	(0.079)	(0.171)	(0.178)	(0.210)
MDD-W	0.301	0.245	0.441	0.303	0.039	-0.043	0.185***
	(0.017)	(0.015)	(0.023)	(0.013)	(0.028)	(0.029)	(0.034)

Note: * 0.1 ** 0.05 ***0.01. Columns 1 to 4 show the post-treatment unconditional averages of the outcome variables. Columns 5 to 7 show, respectively, the average effect of the CASU alone, the HGSF alone and of the combined treatments.

Looking at the single foods that compose the WDDS in Table 48, we see that the positive effects of CASU are related to increases in the consumption of cereals, dark green vegetables, flesh meat and legumes. The reasons behind the negative impacts of HGSF on WDDS lay in reduced consumption of cereals, orange roots and tubers, legumes, milk products, and oil and fats. The combined treatment is associated with reduced consumption of cereals, fish, and oil and fats, and increased consumption of white roots and tubers, meat and legumes.

Table 48: Women's dietary diversity components

	CASU	HGSF	Both	Control	CASUvsCtrl	HGSFvsCtrl	BothvsCtrl
Cereals	0.925	0.414	0.502	0.712	0.150***	-0.362***	-0.227***
	(0.012)	(0.021)	(0.025)	(0.015)	(0.034)	(0.034)	(0.037)
White roots & tubers	0.296	0.216	0.360	0.311	0.074**	-0.008	0.116***
	(0.021)	(0.018)	(0.024)	(0.015)	(0.036)	(0.036)	(0.038)
Orange roots & tubers	0.251	0.179	0.316	0.250	-0.013	-0.066**	0.055
	(0.020)	(0.016)	(0.023)	(0.014)	(0.033)	(0.033)	(0.035)
Dark green vegetables	0.894	0.614	0.681	0.681	0.252***	-0.039	0.071*
	(0.014)	(0.021)	(0.023)	(0.015)	(0.034)	(0.034)	(0.037)
Other vegetables	0.653	0.625	0.630	0.664	0.001	0.007	0.010
	(0.022)	(0.021)	(0.024)	(0.015)	(0.037)	(0.037)	(0.040)
Orange fruits	0.290	0.235	0.301	0.242	0.082**	0.006	0.030
	(0.021)	(0.018)	(0.023)	(0.014)	(0.034)	(0.034)	(0.037)
Other fruits	0.332	0.477	0.429	0.444	-0.111***	0.065*	0.006
	(0.022)	(0.021)	(0.025)	(0.016)	(0.039)	(0.039)	(0.042)
Organ meat	0.228	0.107	0.265	0.186	0.059**	-0.058*	0.124***
	(0.019)	(0.013)	(0.022)	(0.013)	(0.030)	(0.030)	(0.032)
Flesh meat	0.446	0.273	0.525	0.362	0.134***	-0.073*	0.159***
	(0.023)	(0.019)	(0.025)	(0.016)	(0.038)	(0.038)	(0.041)
Eggs	0.452	0.517	0.486	0.491	0.003	0.065*	0.060
	(0.023)	(0.021)	(0.025)	(0.016)	(0.039)	(0.039)	(0.042)
Fish	0.504	0.454	0.224	0.461	0.035	-0.054	-0.310***
	(0.023)	(0.021)	(0.021)	(0.016)	(0.038)	(0.038)	(0.041)
Legumes, nuts & seeds	0.388	0.292	0.536	0.354	0.096***	-0.062*	0.192***
	(0.022)	(0.020)	(0.025)	(0.016)	(0.037)	(0.037)	(0.040)
Milk & milk products	0.371	0.111	0.403	0.226	0.153***	-0.130***	0.168***
	(0.022)	(0.013)	(0.024)	(0.014)	(0.033)	(0.034)	(0.036)
Oil & fats	0.817	0.624	0.666	0.752	0.026	-0.151***	-0.122***
	(0.018)	(0.021)	(0.023)	(0.014)	(0.034)	(0.034)	(0.037)
Sweets	0.306	0.291	0.253	0.267	-0.018	0.015	-0.033
	(0.021)	(0.020)	(0.022)	(0.015)	(0.035)	(0.035)	(0.037)
Spices	0.383	0.126	0.179	0.176	0.150***	-0.055*	-0.048
	(0.022)	(0.014)	(0.019)	(0.012)	(0.031)	(0.031)	(0.033)

Note: * 0.1 ** 0.05 ***0.01. Columns 1 to 4 show the post-treatment unconditional averages of the outcome variables. Columns 5 to 7 show, respectively, the average effect of the CASU alone, the HGSF alone and of the combined treatments.

The Food Insecurity Experience Scale (FIES) is based on eight questions with dichotomous yes/no responses (Ballard *et al*., 2013). It is a statistical scale designed to cover a range of severity of food insecurity. The questions focus on self-reported food-related behaviours and experiences associated with increasing difficulty in accessing food due to resource constraints. The scale ranges between 0 and 8 and a negative impact denotes a reduction in food insecurity. The first line of Table 49 shows results for the aggregate scale, while the subsequent lines analyse the impacts based on each of the eight questions that compose the scale. The respondent answers the following questions on behalf of the whole household. During the last 12 months, has there has been a time when, because of lack of money or other resources:

1. You were *worried* you would not have enough food to eat?
2. You were *unable* to eat healthy and nutritious food?
3. You ate only a *few* kinds of foods?
4. You had to *skip* a meal?
5. You ate *less* than you thought you should?
6. Your household *ran out* of food?
7. You were *hungry* but did not eat?
8. You went *without eating* for a whole day?

From Table 49 see that the food insecurity situation is more severe in the HGSF and combined treatment groups, where the score is above 5 *vis-à-vis* a score of 4.6 in the CASU group. Given the increasing severity of food insecurity inherent in the wording of the questions, we expect a lower share of households to answer yes as the enumerator moves from one question to the next. This property can be observed in the CASU group, where 74.4 percent of household declare to have been worried they would not have enough food, but a considerably lower share declare to have gone without eating for a whole day (27.1%). The same pattern of more severe conditions of food insecurity finding a smaller spread in the population is also observed for the HGSF sample. In the HGSF group and the combined group, the share of respondents that declare to have gone a whole day without eating is particularly high, at 60 percent. In terms of impacts, CASU is associated with reductions of food insecurity across all severity levels. HGSF leads to increased food insecurity in the household across all severity levels. The combination of the programmes has mostly no impact on food insecurity, with the exception of the share of people that declare to have gone a whole day without eating, which increases by 20 percent.

Table 49: Household food insecurity

	CASU	HGSF	Both	Control	CASUvsCtrl	HGSFvsCtrl	BothvsCtrl
FIES	4.610	5.765	5.535	5.746	-1.054***	0.542***	0.063
	(0.108)	(0.101)	(0.142)	(0.079)	(0.178)	(0.185)	(0.219)
worried	0.744	0.849	0.770	0.801	-0.065***	0.088***	0.013
	(0.016)	(0.013)	(0.020)	(0.011)	(0.025)	(0.026)	(0.030)
unable	0.733	0.822	0.749	0.809	-0.058**	0.058**	-0.015
	(0.016)	(0.014)	(0.020)	(0.011)	(0.025)	(0.027)	(0.031)
ate few	0.727	0.823	0.735	0.800	-0.053**	0.081***	-0.023
	(0.016)	(0.014)	(0.020)	(0.011)	(0.025)	(0.027)	(0.031)
skip	0.566	0.748	0.657	0.737	-0.162***	0.095***	-0.051
	(0.018)	(0.016)	(0.022)	(0.012)	(0.028)	(0.029)	(0.034)
ate less	0.633	0.799	0.715	0.770	-0.128***	0.087***	-0.058*
	(0.017)	(0.014)	(0.021)	(0.012)	(0.027)	(0.028)	(0.033)
ran out	0.460	0.720	0.657	0.664	-0.187***	0.145***	0.021
	(0.018)	(0.016)	(0.022)	(0.013)	(0.029)	(0.031)	(0.036)
hungry	0.491	0.702	0.672	0.692	-0.206***	0.090***	0.004
	(0.018)	(0.016)	(0.022)	(0.013)	(0.029)	(0.030)	(0.035)
no eating	0.271	0.600	0.609	0.551	-0.264***	0.106***	0.103***
	(0.016)	(0.018)	(0.023)	(0.014)	(0.030)	(0.031)	(0.036)

Note: * 0.1 ** 0.05 ***0.01. Columns 1 to 4 show the post-treatment unconditional averages of the outcome variables. Columns 5 to 7 show, respectively, the average effect of the CASU alone, the HGSF alone and of the combined treatments.

Food consumption from purchases and own production

In the previous section we looked at the impacts of the programmes on dietary diversity and food insecurity indicators. To gain a more tangible view of food consumption patterns at the household level, we now look at the impacts of the programmes on the two main sources of food consumed at home – namely, from own production and from market purchases. Table 50 shows results for consumption from own production of major crops. In all groups except the HGSF group, consumption is considerably skewed in favour of maize, while groundnuts occupy the second position but still amount to one-tenth of the amount of maize. In the HGSF group, maize is still the most important food item but counts for less than one-half of the amounts consumed in the other groups. However, cross-referencing the results from Table 50 with those of Table 5, it would appear that there is minimal difference between CASU and HGSF farmers in terms of the share of total harvest of maize and beans they are consuming; in both arms, one-fourth of the maize harvest is consumed from own production and about one-third in the case of beans. In terms of impacts, CASU is associated with increased consumption of own-produced maize, cowpeas and sweet potatoes at the expense of cassava, millet and sorghum. HGFS stimulates consumption of own-produced beans and discourages consumption of maize and sorghum. The combined HGSF and CASU treatment leads farmers to consume more own-produced maize, groundnuts and sweet potatoes.

Table 50: Crop consumption from own production, in kg

	CASU	HGSF	Both	Control	CASUvsCtrl	HGSFvsCtrl	BothvsCtrl
Beans	11.847	270.757	11.440	20.997	-14.780	341.838***	-17.417
	(3.645)	(153.783)	(5.769)	(2.256)	(114.725)	(119.084)	(142.311)
Cowpeas	9.940	0.279	2.863	0.686	5.870***	-0.242	-0.171
	(1.554)	(0.139)	(0.849)	(0.373)	(1.262)	(1.321)	(1.568)
Maize	858.745	326.515	1,113.619	672.586	158.614**	-359.051***	315.301***
	(30.134)	(14.175)	(56.859)	(42.837)	(64.641)	(67.910)	(79.280)
Cassava	0.181	21.460	2.159	19.304	-19.545**	11.241	-16.273
	(0.137)	(5.726)	(1.688)	(5.625)	(9.359)	(9.985)	(11.692)
Groundnuts	66.754	41.025	109.769	31.543	27.386	5.354	65.633***
	(4.616)	(3.443)	(8.639)	(14.872)	(19.516)	(20.864)	(24.065)
Millet	0.000	12.430	0.000	11.964	-14.369**	-7.091	-14.369*
	(.)	(2.669)	(.)	(4.790)	(6.392)	(6.873)	(7.985)
Sorghum	0.118	0.000	0.227	12.568	-13.483***	-13.537***	-13.508***
	(0.078)	(.)	(0.161)	(2.644)	(3.323)	(3.589)	(4.151)
Sugar cane	6.737	0.000	25.682	22.208	-46.452	-34.480	-24.732
	(4.517)	(.)	(25.008)	(21.176)	(28.450)	(30.707)	(35.513)
Soybeans	9.825	0.518	13.510	1.775	4.318	-2.365	11.623*
	(5.336)	(0.322)	(1.667)	(0.746)	(5.307)	(5.728)	(6.547)
Sunflowers	7.191	0.000	137.904	0.000	5.613	0.000	314.022***
	(1.857)	(.)	(67.251)	(.)	(54.436)	(58.755)	(67.623)
Potatoes	2.368	0.901	0.000	0.581	2.357	1.341	0.101
	(1.772)	(0.754)	(.)	(0.426)	(1.678)	(1.811)	(2.094)
Sweet potatoes	57.522	8.678	28.083	13.069	30.329***	-1.426	38.143***
	(5.733)	(2.123)	(12.174)	(2.231)	(9.737)	(10.510)	(12.138)

Note: * 0.1 ** 0.05 ***0.01. Columns 1 to 4 show the post-treatment unconditional averages of the outcome variables. Columns 5 to 7 show, respectively, the average effect of the CASU alone, the HGSF alone and of the combined treatments.

In Table 51, we look at the impacts of the programmes on the consumption of livestock from owned herds. The most commonly butchered animals from owned livestock are chickens and goats, with very little butchering of other animals. Households consume between two and six chickens a year, while goat consumption is below one unit. Impacts are also concentrated on chickens alone. CASU increases the consumption of chickens by 42 percent while HGSF is associated with a reduction of 62 percent in the consumption of chickens and with a considerable reduction in the consumption of other poultry, such as ducks.

Table 51: Livestock consumption from own production

	CASU	HGSF	Both	Control	CASUvsCtrl	HGSFvsCtrl	BothvsCtrl
Milk cows	0.014	0.008	0.048	0.010	-0.006	-0.023	0.052***
	(0.006)	(0.006)	(0.016)	(0.007)	(0.014)	(0.018)	(0.018)
Other cattle	0.053	0.017	0.083	0.005	0.016	-0.004	0.040
	(0.017)	(0.011)	(0.021)	(0.004)	(0.021)	(0.027)	(0.027)
Sheep	0.002	0.009	0.011	0.005	0.003	0.011	0.019**
	(0.002)	(0.006)	(0.008)	(0.004)	(0.008)	(0.009)	(0.009)
Goats	0.947	0.334	0.263	0.355	-0.052	-0.046	-0.135
	(0.484)	(0.039)	(0.047)	(0.059)	(0.416)	(0.517)	(0.513)
Pigs	0.047	0.018	0.129	0.048	0.008	0.000	0.070**
	(0.015)	(0.009)	(0.030)	(0.011)	(0.027)	(0.035)	(0.033)
Chickens	5.941	2.009	3.844	3.896	1.632***	-2.526***	-0.702
	(0.287)	(0.165)	(0.306)	(0.353)	(0.591)	(0.768)	(0.729)
Guinea fowl	0.119	0.000	0.013	0.045	0.007	-0.066	-0.069
	(0.033)	(.)	(0.009)	(0.025)	(0.044)	(0.059)	(0.055)
Rabbits	0.011	0.012	0.011	0.006	-0.002	0.017	0.006
	(0.009)	(0.009)	(0.011)	(0.006)	(0.010)	(0.013)	(0.012)
Ducks&Geese	0.126	0.006	0.070	0.132	-0.169*	-0.230**	-0.118
	(0.035)	(0.004)	(0.025)	(0.057)	(0.086)	(0.114)	(0.106)
Other	0.098	0.358	0.086	0.139	0.183	0.426*	0.055
	(0.094)	(0.315)	(0.065)	(0.042)	(0.188)	(0.249)	(0.232)

Note: * 0.1 ** 0.05 ***0.01. Columns 1 to 4 show the post-treatment unconditional averages of the outcome variables. Columns 5 to 7 show, respectively, the average effect of the CASU alone, the HGSF alone and of the combined treatments.

We now look at the impacts of the programmes on food consumption expenditure over the week preceding the survey. The last line of Table 52 shows total food expenditure by the household. HGSF and its combination with CASU are associated with reduced food expenditures of 36 and 37 percent, respectively. CASU does not have a significant influence on total food consumption expenditure, although there are small increases induced by the programme – for instance, in the expenditure for cereals and legumes. In the case of HGSF, the reduction in total food consumption expenditure is caused by reduced spending for legumes (93%) and meat (56%). In the case of legumes, it could be that HGSF farmers are spending less because they consume more of what they are producing. For the combined group, the reduction in total food expenditure is driven by reductions in the consumption of fish (80%) and oil and fats (60%).

Table 52: Food consumption expenditure

	CASU	HGSF	Both	Control	CASUvsCtrl	HGSFvsCtrl	BothvsCtrl
Cereals	21.937	24.370	26.594	19.915	9.091**	4.956	1.816
	(1.770)	(1.929)	(3.341)	(1.503)	(3.768)	(3.917)	(4.622)
White roots & tubers	3.486	3.753	4.850	3.789	-0.271	2.646**	1.094
	(0.443)	(0.966)	(0.736)	(0.513)	(1.180)	(1.246)	(1.447)
Orange roots & tubers	2.018	2.708	2.768	2.957	-1.637	-0.687	-1.558
	(0.394)	(0.450)	(0.417)	(0.794)	(1.624)	(1.719)	(1.992)
Dark green vegetables	9.205	5.630	4.762	9.697	0.046	-2.284**	-3.651***
	(0.497)	(0.683)	(0.467)	(0.453)	(0.964)	(1.022)	(1.182)
Other vegetables	4.856	5.839	4.292	8.169	-5.595	-3.806	-6.272
	(0.468)	(0.824)	(0.387)	(2.336)	(4.628)	(4.925)	(5.676)
Orange fruits	3.876	1.140	2.021	1.508	3.339**	-0.738	0.139
	(1.587)	(0.196)	(0.322)	(0.177)	(1.388)	(1.481)	(1.703)
Other fruits	2.279	1.307	2.191	1.976	0.125	-1.197**	0.240
	(0.283)	(0.221)	(0.381)	(0.271)	(0.510)	(0.544)	(0.626)
Organ meat	4.207	2.931	4.912	4.968	-1.104	-2.584**	-0.027
	(0.749)	(0.400)	(0.832)	(0.755)	(1.098)	(1.181)	(1.346)
Flesh meat	18.191	8.082	15.833	16.983	-0.627	-9.429***	-2.980
	(1.445)	(0.674)	(1.163)	(1.878)	(2.942)	(3.163)	(3.607)
Eggs	8.657	8.551	8.300	8.889	-5.222**	-0.630	-3.694
	(1.078)	(0.514)	(1.396)	(0.680)	(2.226)	(2.392)	(2.728)
Fish	20.113	12.777	4.453	18.295	-0.851	-5.938***	-14.776***
	(1.175)	(0.779)	(0.582)	(0.851)	(1.659)	(1.783)	(2.034)
Legumes, nuts & seeds	6.648	0.704	3.039	4.411	2.357**	-4.135***	-1.311
	(0.816)	(0.181)	(0.592)	(0.379)	(0.920)	(0.988)	(1.127)
Milk & milk products	4.824	1.876	3.893	4.063	-0.182	-3.006***	-1.782**
	(0.369)	(0.258)	(0.577)	(0.331)	(0.644)	(0.693)	(0.790)
Oil & fats	20.753	12.870	10.006	21.564	-3.165**	-9.462***	-13.385***
	(0.854)	(0.531)	(0.941)	(0.878)	(1.486)	(1.599)	(1.821)
Sweets	6.672	1.877	1.288	2.599	1.565***	-1.122*	-1.706***
	(1.440)	(0.215)	(0.189)	(0.221)	(0.539)	(0.580)	(0.660)
Spices	4.076	1.017	1.474	3.037	-0.138	-2.385***	-1.489
	(0.469)	(0.145)	(0.306)	(0.452)	(0.794)	(0.856)	(0.972)
Total food expenditure	141.128	91.889	100.460	131.776	-1.714	-47.763***	-48.459***
	(5.261)	(4.805)	(5.716)	(5.719)	(11.255)	(11.682)	(13.808)

Note: * 0.1 ** 0.05 ***0.01. Columns 1 to 4 show the post-treatment unconditional averages of the outcome variables. Columns 5 to 7 show, respectively, the average effect of the CASU alone, the HGSF alone and of the combined treatments.

In a nutshell, school meals alone seem to improve children's and women's dietary diversity, but HGSF as a whole is associated with reductions of children's and women's dietary diversity and increased food insecurity for the household. CASU is associated with improvements of children's and women's dietary diversity and reduced food insecurity for the household. The combination of the two programmes has mostly positive effects on children's and women's dietary diversity.

5.4.Schooling and children's time use

For school outcomes we follow the same approach as for FNS outcomes. First we analyse the impact of the school meals supplied by HGSF by themselves and then we present results for the standard analysis where we compare each of the three treatment groups with the comparison group. For both types of analysis we divide the sample into primary and secondary school children. This should allow us to be better able to capture the effects of the meals component of the HGSF on its intended target group, i.e. primary school children, without leaving their older siblings out of the analysis.

Effects of the school meals on schooling indicators

Table 53 shows impact estimates for the HGSF school meals on schooling outcomes for primary school children. We note that only 38.9 percent of these children answered yes to the question of whether they can read. Around 90 percent of primary school children passed the grade from the previous academic year, while almost everyone in the sample (97%) is attending school in the current academic year. Only 2.3 percent of primary school children have dropped out of school from the previous academic year. The number of days attended in the preceding two weeks is around 9 out of 10 possible days. In terms of impacts, meals increase the share of those attending by 5.4 percentage points, reducing further the already low drop-out rate. By stimulating attendance, meals are also associated with a higher share of literate children.

Table 53: Impacts on schooling – primary school children

	Average	Impact
Can read	0.389	0.151***
	(0.019)	(0.056)
Passed grade	0.905	-0.063
	(0.016)	(0.049)
Dropped out	0.023	-0.035*
	(0.007)	(0.019)
Currently attend	0.970	0.053**
	(0.008)	(0.022)
Days attended	8.634	-0.348
	(0.110)	(0.335)
Attended previous year	0.814	0.049
	(0.019)	(0.058)

Note: * 0.1 ** 0.05 ***0.01. Column 1 shows the post-treatment unconditional averages of the outcome variables in the HGSF-only group. Column 2 shows the impact. Standard errors are shown in parentheses.

Table 54 shows results of the HGSF meals on schooling outcomes for secondary school children. The share of those who can read is higher (82.3 percent) than for primary school children, since this group has spent more time in school. Drop-out rate is also higher, at 6.5 percent. The share of children who attend the current academic year stands at 75.5 percent, more than 20 percentage points lower than for primary school children. The meals appear to be associated with a higher share of children who pass the grade (+6 percent) and an increase in the attendance rate (+14.3 percent).

Table 54: Impacts on schooling – secondary school children

	Average	Impact
Can read	0.823	-0.008
	(0.016)	(0.039)
Passed grade	0.943	0.061*
	(0.012)	(0.033)
Dropped out	0.065	0.013
	(0.011)	(0.030)
Currently attend	0.755	0.108**
	(0.020)	(0.053)
Days attended	9.168	-0.005
	(0.090)	(0.253)
Attended previous year	0.811	0.127***
	(0.018)	(0.047)

Note: * 0.1 ** 0.05 ***0.01. Column 1 shows the post-treatment unconditional averages of the outcome variables in the HGSF-only group. Column 2 shows the impact. Standard errors are shown in parentheses.

Primary schools

We now return to the standard analysis whereby we compare the school outcomes of each of the three treatment groups to the schooling outcomes in the control group. The analysis is at the individual level. Table 55 shows results for primary school children. The CASU programme alone appears to have no significant impacts on schooling outcomes except that the share of those passing the grade increases by a small amount. By contrast, HGSF is associated with a sizable reduction in educational expenditure (31%), while the reductions in the number of days attended in the last two weeks and in the share of literate children are statistically significant, but of very small magnitude. The combination of treatments has particularly significant and negative impacts on schooling indicators. The share of children passing to the next grade from the previous year reduces by 13.5 percent while the share of those currently attending reduces by 10.8 percent. The number of days attended in the last two weeks reduces by 4 days, or 45 percent in relative terms. The combined treatment does not cause any reductions in educational expenditure.

Table 55: Impacts on schooling – primary school children

	CASU	HGSF	Both	Control	CASUvsCtrl	HGSFvsCtrl	BothvsCtrl
Can read	0.479	0.389	0.322	0.454	-0.009	-0.083**	-0.127***
	(0.017)	(0.019)	(0.024)	(0.015)	(0.032)	(0.037)	(0.039)
Passed grade	0.929	0.905	0.818	0.886	0.049**	0.014	-0.120***
	(0.012)	(0.016)	(0.033)	(0.013)	(0.025)	(0.029)	(0.036)
Dropped out	0.015	0.023	0.019	0.015	-0.002	-0.004	0.003
	(0.005)	(0.007)	(0.010)	(0.004)	(0.009)	(0.011)	(0.012)
Currently attend	0.985	0.970	0.869	0.974	0.017	0.018	-0.106***
	(0.005)	(0.008)	(0.024)	(0.006)	(0.016)	(0.019)	(0.021)
Days attended	8.894	8.634	4.313	8.808	-0.004	-0.362*	-4.009***
	(0.087)	(0.110)	(0.236)	(0.075)	(0.183)	(0.212)	(0.244)
Attended previous year	0.833	0.814	0.684	0.851	0.037	-0.013	-0.176***
	(0.016)	(0.019)	(0.032)	(0.013)	(0.030)	(0.035)	(0.039)
Grade completion	3.004	2.882	2.243	2.845	-0.037	0.215	-0.127
	(0.091)	(0.088)	(0.133)	(0.073)	(0.154)	(0.182)	(0.189)
Educational expenses	247.463	208.040	225.319	240.736	3.481	-75.582*	47.248
	(18.849)	(17.457)	(38.592)	(17.894)	(38.256)	(44.759)	(54.886)

Note: * 0.1 ** 0.05 ***0.01. Columns 1 to 4 show the post-treatment unconditional averages of the outcome variables. Columns 5 to 7 show, respectively, the average effect of the CASU alone, the HGSF alone and of the combined treatments.

The impacts on some school indicators, especially those related to the time spent by children at school, can be better understood if interpreted against the backdrop of the programme impacts on children's time use. Households were asked how many hours per day a child spent on the list of activities shown in Table 56, in the last seven days. We observe that most of the time goes for school activities, followed by fetching water or firewood, doing chores and working on their own farms. The CASU programme is associated with increased time spent on school-related activities, but also with more time dedicated to livestock herding and to work in own NFBs. This time is compensated for by a reduction in the part of the day dedicated to paid work outside of the farm. The HGSF programme alone discourages the use of children's time in activities related to chores, own farm work and own NFBs, but has no effect on the time dedicated to school-related activities. The combined treatment seems to reduce by half an hour (13.7%) the time dedicated to school-related activities.

Table 56: Impacts on children's time use – primary schools

	CASU	HGSF	Both	Control	CASUvsCtrl	HGSFvsCtrl	BothvsCtrl
Fetching	0.950	1.019	0.743	1.029	0.007	0.039	-0.052
	(0.027)	(0.041)	(0.070)	(0.026)	(0.057)	(0.066)	(0.076)
Chores	0.899	0.749	0.765	0.919	0.038	-0.236***	-0.082
	(0.034)	(0.042)	(0.068)	(0.030)	(0.063)	(0.073)	(0.084)
School activities	4.320	2.983	2.754	3.334	1.184***	-0.259	-0.456**
	(0.082)	(0.108)	(0.174)	(0.078)	(0.161)	(0.187)	(0.216)
Own farm	1.034	1.002	0.989	0.979	0.069	-0.251**	0.022
	(0.057)	(0.075)	(0.099)	(0.047)	(0.104)	(0.120)	(0.139)
Livestock	0.411	0.119	0.089	0.139	0.321***	-0.050	-0.035
	(0.051)	(0.044)	(0.028)	(0.027)	(0.073)	(0.085)	(0.098)
NFB	0.225	0.029	0.156	0.217	0.186***	-0.148**	0.045
	(0.032)	(0.020)	(0.045)	(0.027)	(0.051)	(0.059)	(0.068)
Paid work	0.090	0.240	0.229	0.191	-0.132**	0.026	0.023
	(0.028)	(0.052)	(0.065)	(0.028)	(0.067)	(0.078)	(0.089)

Note: * 0.1 ** 0.05 ***0.01. Columns 1 to 4 show the post-treatment unconditional averages of the outcome variables. Columns 5 to 7 show, respectively, the average effect of the CASU alone, the HGSF alone and of the combined treatments.

Secondary schools

We now repeat the analysis of the previous subsection for secondary school children. Table 57 shows results for schooling indicators, while Table 58 illustrates results for children's time use. From Table 57 we see that CASU alone has no impacts on any schooling indicator for secondary school children. Being in an HGSF beneficiary household leads to an increase in the share of secondary school children passing their grade (+8.4%). The combination of CASU with HGSF shows a strong reduction (51.7%) in the number of days of school attended in the last two weeks. Neither of the programmes has a significant effect on educational expenditure for secondary school children. We notice, nonetheless, that households spend 3-5 times as much on education for secondary school children as they do for primary school children.

Table 57: Impacts on schooling – secondary school children

	CASU	HGSF	Both	Control	CASUvsCtrl	HGSFvsCtrl	BothvsCtrl
Can read	0.906	0.823	0.787	0.834	0.036	0.052*	-0.008
	(0.013)	(0.016)	(0.022)	(0.012)	(0.031)	(0.030)	(0.031)
Passed grade	0.942	0.943	0.873	0.866	-0.005	0.073**	-0.015
	(0.012)	(0.012)	(0.021)	(0.014)	(0.033)	(0.033)	(0.033)
Dropped out	0.067	0.065	0.056	0.066	-0.035	-0.004	-0.024
	(0.011)	(0.011)	(0.013)	(0.009)	(0.024)	(0.023)	(0.023)
Currently attends	0.782	0.755	0.805	0.791	0.037	-0.005	0.027
	(0.019)	(0.020)	(0.022)	(0.014)	(0.041)	(0.039)	(0.039)
Days attended	8.179	9.168	4.123	8.717	-0.379	0.334	-4.528***
	(0.163)	(0.090)	(0.223)	(0.092)	(0.306)	(0.301)	(0.291)
Attended previous year	0.843	0.811	0.836	0.844	0.004	-0.013	-0.061*
	(0.016)	(0.018)	(0.021)	(0.013)	(0.037)	(0.035)	(0.035)
Grade completion	7.408	7.126	6.380	7.314	0.375	0.136	-0.431*
	(0.093)	(0.119)	(0.167)	(0.089)	(0.233)	(0.223)	(0.228)
Educational expenses	959.152	1,111.959	673.328	945.210	-50.475	-58.016	-185.668
	(70.269)	(262.260)	(104.066)	(181.043)	(293.015)	(290.068)	(294.306)

Note: * 0.1 ** 0.05 ***0.01. Columns 1 to 4 show the post-treatment unconditional averages of the outcome variables. Columns 5 to 7 show, respectively, the average effect of the CASU alone, the HGSF alone and of the combined treatments.

Table 58 shows results for the allocation of children's time during the day. Secondary school children spend more time on almost all activities, both school and work-related, compared with their younger siblings. Secondary school children also dedicate most of the day to school-related activities, followed by fetching firewood and water as well as house chores. The CASU programme leads to a reallocation of time during the day, decreasing the hours dedicated to fetching (15%) and increasing time dedicated to school activities (15.7%), to livestock herding (200%) and to working in own NFBs (160%). HGSF has no impact on the way secondary children allocate their time during the day. The combination of HGSF with CASU reduces time dedicated to fetching activities (-30%), chores (-27%) and school activities (-25%). The time thus freed is not employed in any other activity during the day.

Table 58: Impacts on children's time use – secondary schools

	CASU	HGSF	Both	Control	CASUvsCtrl	HGSFvsCtrl	BothvsCtrl
Fetching	1.236	1.514	1.180	1.449	-0.215**	-0.084	-0.435***
	(0.040)	(0.052)	(0.085)	(0.042)	(0.104)	(0.104)	(0.103)
Chores	1.326	1.504	1.026	1.453	-0.167	-0.023	-0.396***
	(0.052)	(0.057)	(0.074)	(0.042)	(0.113)	(0.113)	(0.112)
School activities	5.112	4.087	3.159	3.998	0.627**	-0.306	-1.041***
	(0.140)	(0.146)	(0.188)	(0.109)	(0.293)	(0.293)	(0.291)
Own farm	1.792	1.920	1.952	1.763	-0.076	0.010	0.147
	(0.087)	(0.096)	(0.151)	(0.072)	(0.198)	(0.198)	(0.197)
Livestock	0.631	0.239	0.312	0.196	0.416***	-0.011	-0.020
	(0.088)	(0.074)	(0.085)	(0.044)	(0.147)	(0.147)	(0.146)
NFB	0.391	0.091	0.180	0.318	0.516***	-0.023	0.105
	(0.057)	(0.024)	(0.047)	(0.037)	(0.093)	(0.093)	(0.092)
Paid work	0.153	0.257	0.286	0.257	0.051	0.082	0.009
	(0.045)	(0.056)	(0.057)	(0.036)	(0.113)	(0.113)	(0.112)

Note: * 0.1 ** 0.05 ***0.01. Columns 1 to 4 show the post-treatment unconditional averages of the outcome variables. Columns 5 to 7 show, respectively, the average effect of the CASU alone, the HGSF alone and of the combined treatments.

To sum up, meals *per se* have a positive impact on most schooling outcomes. Both CASU and HGSF do not have significant impacts on the main schooling indicators, for either primary or secondary school-aged children. Their combination shows detrimental effects on most schooling indicators, especially on attendance.

5.5. Other outcomes

Risk attitudes

Risk attitudes are important determinants of any entrepreneurial and productive activity, including farming. Risk is an uncertainty that can have a positive or negative effect on one or more objectives and risk attitudes are chosen responses to perceptions of significant uncertainty. A range of possible attitudes can be adopted towards the same situation, and these result in differing behaviours, which lead to differing consequences. Risk aversion is a type of attitude where an individual gravitates towards certain, as opposed to uncertain, events. Risk seeking is a type of attitude or behaviour where a person is inclined to take on less-certain activities in lieu of more certain ones. In the middle are risk-neutral individuals, who have an indifferent attitude toward risk.

The existing literature on risk behaviour suggests various methods to measure risk attitude. We use a non-incentivized elicitation method proposed by Brick *et al*. (2012), which consists of asking the respondent a series of questions organized as choices between two options: one of winning a given amount of money with certainty and one of participating in a simple lottery where the respondent can win a high amount with probability x or a smaller amount with probability y. The elicitation

method is non-incentivized, meaning that there is no actual exchange of money involved and the payoffs are only hypothetical, although credible and compatible with the average income level in the rural context of Zambia.
The experiment design used in Brick *et al*. (2012), instead of keeping payoffs constant and varying the probabilities of receiving the high or low outcomes, proposes that the probabilities are constant and the payoffs are varied. Fixed probabilities of 100 and 50 percent were used in the experiment.

Lottery number	I am going to ask you several times whether you prefer to play a lottery that gives you a 50/50 chance to win 100 Maluti or nothing *or* to obtain a safe amount. Each time the safe amount decreases a little. **ENUMERATOR:** Phrase each of the 8 questions in the following way, by changing the safe amount each time: Would you like to play in a lottery that gives you a 50/50 chance to win 100 Kwatchas or 0 or to receive 100 Kwatchas immediately?	
	Option 1	**Option 2**
1	100 : 0	100
2	100 : 0	75
3	100 : 0	60
4	100 : 0	50
5	100 : 0	40
6	100 : 0	30
7	100 : 0	20
8	100 : 0	10

In the first choice question, for example, option 2 (the safe option) offers a 100 percent chance to win ZMK 100, while option 1 (the lottery) offers a 50 percent chance to either win ZMK 100 or ZMK 0 (see illustration of the question above). The payoff associated with option 2 declines systematically throughout the eight iterations from ZMK 100 to ZMK 10, while the payoff for option 1 remains unchanged and is fixed at ZMK 100 and ZMK 0. A highly risk-seeking participant would choose option 1 in the first choice task, while a highly risk-averse participant would choose option 2 in the eighth choice task. A risk-neutral participant would switch from choosing option A to option B in row four, when the expected value of both is approximately the same.
Results are shown in Table 59. The first row shows the findings for the number of times the respondent chose the safe option before switching to the risky option. In order to interpret the results, as a general rule we note that the higher the number of safe choices the more risk- averse the respondent. More specifically, if the number of safe choices ranges between 0 and 3, then the individual is risk-seeking, if it equals 4 the individual is risk-neutral and if it ranges between 5 and 8, the individual is risk-averse. We see that the sample population has a high degree of aversion to risk, preferring the safe option 6-7 times before choosing to take part in the risky lottery (first row in Table 59). In the second to last row we look at the share of households that classify as risk-seeking, risk-neutral and risk-averse, respectively. The share of risk-neutral households is similar across all

groups. The treatment groups differ when it comes to their composition in terms of risk-averse vs risk-seeking individuals. The HGSF group shows a higher share of risk-seeking individuals and a lower share of risk-averse individuals, while this pattern is reversed in the case of CASU and its combination with HGSF. In terms of impacts, HGSF seems to stimulate risk-seeking behaviour. This is reflected both in the reduction of the number of safe choices and in the increase of the share of risk-seeking individuals (+12.5%) and the simultaneous decrease in the share of risk-averse individuals (-72%). CASU is associated with a symmetrical reduction in risk-seeking individuals (-50%) and an increase in risk-averse individuals (+12.4%). The combined treatment has no significant impacts on the composition of the groups in terms of risk preferences.

Table 59: Risk attitudes

	CASU	HGSF	Both	Control	CASUvsCtrl	HGSFvsCtrl	BothvsCtrl
# safe choices	7.304	6.311	7.087	6.537	0.836***	-0.486*	0.706**
	(0.084)	(0.171)	(0.148)	(0.084)	(0.169)	(0.251)	(0.278)
Risk seeking	0.075	0.224	0.122	0.165	-0.081***	0.120***	-0.053
	(0.012)	(0.026)	(0.023)	(0.013)	(0.026)	(0.039)	(0.043)
Risk neutral	0.026	0.020	0.015	0.031	-0.018	-0.019	-0.015
	(0.007)	(0.009)	(0.009)	(0.006)	(0.012)	(0.019)	(0.021)
Risk averse	0.899	0.756	0.862	0.805	0.100***	-0.101**	0.067
	(0.014)	(0.027)	(0.025)	(0.014)	(0.028)	(0.042)	(0.047)

Note: * 0.1 ** 0.05 ***0.01. Columns 1 to 4 show the post-treatment unconditional averages of the outcome variables. Columns 5 to 7 show, respectively, the average effect of the CASU alone, the HGSF alone and of the combined treatments.

Aspirations

The section on aspirations and expectations offers a snapshot of how farm households view themselves and their communities at the moment of the interview and in the near future. First, respondents were introduced to the diagram shown in Figure 6. On the top (highest step, with number 10) stand those who are better off – i.e. those in your community who have the highest standard of living and have met their needs. On the bottom (first step, with number 1), stand those who are worse off – i.e. those in your community who cannot meet most of their needs and are facing the most severe deprivations. Households were then asked on which step were most of their neighbours, their friends and their own household (first three lines in Table 60). Almost everyone in the sample places their immediate fellow villagers at around step four. The respondents place themselves at the same level as their neighbours, but place their friends a bit higher. Respondents were also asked where in the scale they expected their households to be in two years and in five years (last two lines). The answers are consistent with an optimistic view of the future.

Figure 6: Aspiration scale

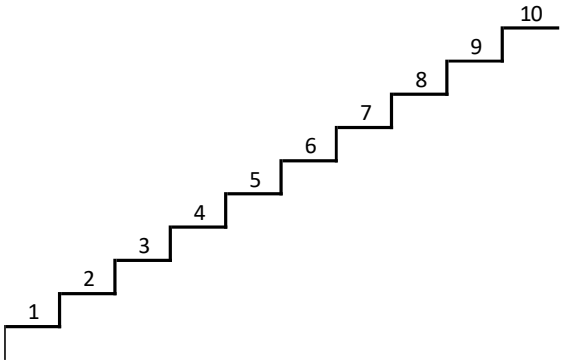


Table 60: General aspirations

	CASU	HGSF	Both	Control	CASUvsCtrl	HGSFvsCtrl	BothvsCtrl
Neighbour	4.147	3.912	4.147	3.762	0.275**	-0.029	0.321**
	-0.072	-0.069	-0.098	-0.059	-0.125	-0.131	-0.153
Friends	4.35	4.161	4.346	3.865	0.368***	0.144	0.300*
	-0.075	-0.074	-0.099	-0.055	-0.127	-0.133	-0.156
HH now	4	3.594	3.686	3.724	0.272**	-0.122	-0.11
	-0.064	-0.07	-0.087	-0.054	-0.113	-0.119	-0.139
HH in two years	5.875	5.222	5.515	5.35	0.358***	-0.213	0.086
	-0.072	-0.083	-0.109	-0.061	-0.132	-0.138	-0.162
HH in five years	7.38	6.723	6.862	6.366	0.800***	0.336**	0.526***
	-0.079	-0.09	-0.109	-0.065	-0.138	-0.144	-0.169

Note: * 0.1 ** 0.05 ***0.01. Columns 1 to 4 show the post-treatment unconditional averages of the outcome variables. Columns 5 to 7 show, respectively, the average effect of the CASU alone, the HGSF alone and of the combined treatments.

Table 61 shows results for the respondent's expectations about their family members. The respondent was asked to think about members of their household below 12 years of age and about the highest educational attainment that they would like them to achieve. In the CASU group, 70 percent of the households would like their children to finish university, while less than 60 percent have this wish in the other groups. When asked about the age they would like children to get married, almost everyone in the sample agrees that this should be 25 years. Figure 7 shows the distribution of answers on the household's expectations about its income in two years for the whole sample. Along the horizontal axis, 1= half the income of the last year, while 6= more than double the income of the last year. Most respondents in the sample expect household income to increase in the next couple of years (categories 4 to 6). The last line of Table 61 shows results for the share of households that expect income to increase in the next two years. The share of those who have an optimistic view on future income in the CASU group (87%) is considerably higher than in the HGSF

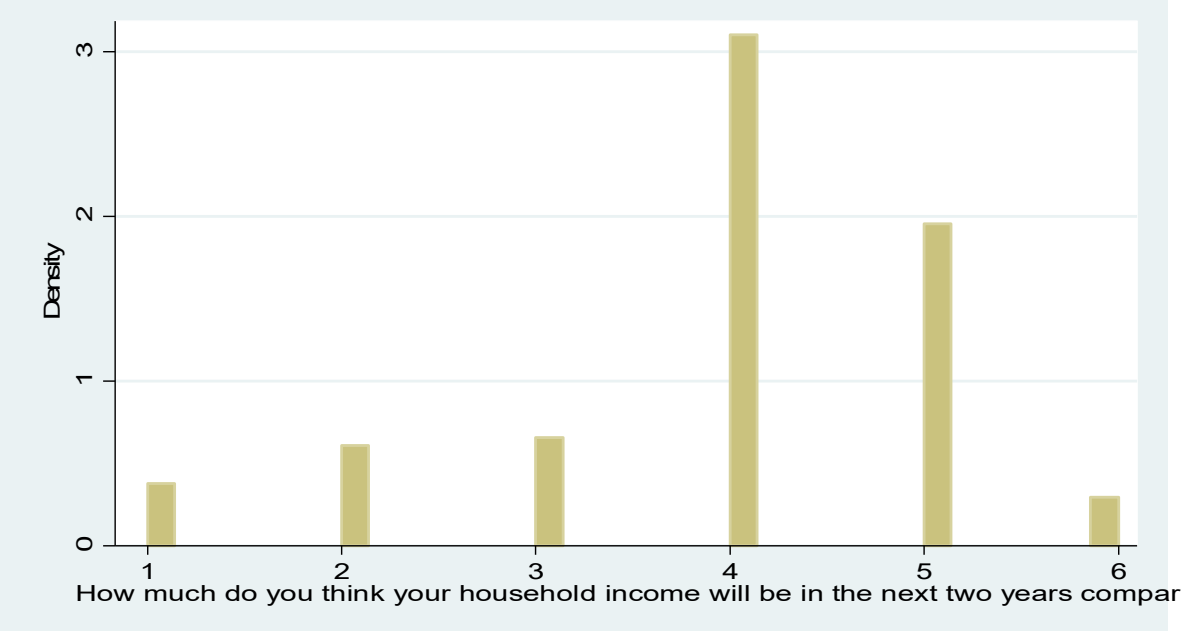
group (64.8%). In terms of impacts, the CASU programme is associated with increased optimism, while HGSF and its combination with CASU seem to reduce the share of households that hold an optimistic view about the future.

Table 61: Aspirations for family members and household income

	CASU	HGSF	Both	Control	CASUvsCtrl	HGSFvsCtrl	BothvsCtrl
Complete university	0.707	0.596	0.588	0.557	0.162***	0.106***	0.084*
	-0.019	-0.022	-0.027	-0.016	-0.036	-0.039	-0.044
Marriage age	25.711	25.337	25.255	26.107	-0.319	-0.969***	-1.288***
	-0.148	-0.211	-0.214	-0.141	-0.314	-0.343	-0.385
More income	0.87	0.648	0.758	0.776	0.058**	-0.165***	-0.059*
	-0.012	-0.017	-0.02	-0.011	-0.025	-0.026	-0.031

Note: * 0.1 ** 0.05 ***0.01. Columns 1 to 4 show the post-treatment unconditional averages of the outcome variables. Columns 5 to 7 show, respectively, the average effect of the CASU alone, the HGSF alone and of the combined treatments.

Figure 7: Expected household income in two years



Note: *1= Half the income of last year; 2= Slightly less than last year; 3= Same as last year; 4= A little more than last year; 5= Twice the income of last year; 6= More than double the income of last year.

Financial literacy

Risk-seeking propensity and financial literacy are both prerequisites for increased entrepreneurial activities, in both the farm and non-farm sectors. In the survey questionnaire several financial literacy indicators were included. In the first question the respondent was asked whether the family

usually keeps a budget to record income and expenditures. The respondent was also asked to perform a simple division problem and an interest rate compounding to measure numeracy. Simple bookkeeping is more widespread among CASU farmers, who also perform better in the simple numeracy test relative to all other groups (Table 62). Households were then asked how often their income does not quite cover their living costs. Compared with other groups, the CASU group has a lower share of farmers who are always short of income but also of those who are never short of income. In the HGSF group we see a reverse pattern of a higher incidence of households that are always short of income and also of those that are never short. By looking at the levels of income where the programmes exercise their influence we can build an idea of their distributional impacts. The CASU programme is associated with an increase in the share of those who are often short of income and a reduction in the share of those who are never short, which could be an indication of increased inequality among beneficiaries. HGSF has a similar pattern of impacts – increasing the share of those who are always short of income and decreasing the ranks of those rarely short of income – with potential inequality-exacerbating consequences. The combined treatment has no significant distributional impacts.

Table 62: Financial and numerical literacy

	CASU	HGSF	Both	Control	CASUvsCtrl	HGSFvsCtrl	BothvsCtrl
Budget	0.505	0.321	0.380	0.454	0.080***	-0.090***	-0.081**
	(0.018)	(0.017)	(0.023)	(0.014)	(0.030)	(0.031)	(0.037)
Division	0.903	0.803	0.845	0.888	0.006	-0.105***	-0.023
	(0.011)	(0.014)	(0.017)	(0.009)	(0.020)	(0.021)	(0.025)
Interest	0.940	0.883	0.826	0.906	0.029*	-0.032*	-0.046**
	(0.009)	(0.011)	(0.018)	(0.008)	(0.018)	(0.019)	(0.022)
Always short	0.173	0.325	0.233	0.192	-0.015	0.119***	0.026
	(0.014)	(0.016)	(0.020)	(0.011)	(0.025)	(0.026)	(0.031)
Often short	0.375	0.157	0.328	0.307	0.064**	-0.106***	-0.018
	(0.017)	(0.013)	(0.022)	(0.013)	(0.028)	(0.029)	(0.034)
Sometimes short	0.314	0.398	0.315	0.355	-0.035	0.031	0.007
	(0.017)	(0.017)	(0.022)	(0.013)	(0.029)	(0.030)	(0.036)
Rarely short	0.095	0.033	0.075	0.068	0.035**	-0.039**	0.001
	(0.011)	(0.006)	(0.012)	(0.007)	(0.015)	(0.016)	(0.018)
Never short	0.039	0.067	0.045	0.064	-0.038***	-0.016	-0.004
	(0.007)	(0.009)	(0.010)	(0.007)	(0.014)	(0.015)	(0.018)

Note: * 0.1 ** 0.05 ***0.01. Columns 1 to 4 show the post-treatment unconditional averages of the outcome variables. Columns 5 to 7 show, respectively, the average effect of the CASU alone, the HGSF alone and of the combined treatments.

Non-food expenditure

A household's non-food expenditures are a good proxy of its spending capacity and well-being. The last line of Table 63 shows results for total non-food expenditure in the three months preceding the survey. Households in the CASU arm spend almost twice as much as those in the other arms. In particular, the expenditure items that drive the gap are for charcoal, public transport, oil for transport vehicles and mobile phone top-ups, while the four groups spend similar amounts for the rest of the items. In terms of impacts, CASU is associated with an increase of 65 percent in total non-food expenditure. The specific items on which CASU farmers spend more include children's clothing, charcoal, public transport, oil for transportation vehicles and mobile phone top-ups. HGSF is associated with reduced non-food spending (25%). HGSF farmers have reduced spending on charcoal, mobile phone top-ups and public transportation. The combined treatment has no significant impact on total non-food spending, but it does affect specific expenditure items. Beneficiaries of the combined programmes increase spending on clothing and shoes for both adults and children and reduce expenditures for mobile phone top-ups and charcoal.

Table 63: Non-food expenditure

	CASU	HGSF	Both	Control	CASUvsCtrl	HGSFvsCtrl	BothvsCtrl
Cigarettes	24.157	3.794	9.418	10.525	8.690	-9.429	-8.379
	(6.614)	(1.557)	(2.247)	(3.701)	(7.748)	(8.058)	(9.506)
Clothes for adults	125.077	118.282	151.925	95.156	30.497**	14.092	43.879**
	(9.701)	(7.242)	(14.724)	(5.879)	(14.580)	(15.402)	(17.877)
Clothes for children	104.712	92.546	139.833	70.467	29.475***	11.739	50.890***
	(7.623)	(6.002)	(13.267)	(4.299)	(11.193)	(11.910)	(13.724)
Shoes for adults	40.281	61.441	56.060	38.269	2.747	22.482***	5.474
	(3.104)	(5.320)	(8.406)	(2.545)	(6.813)	(7.267)	(8.354)
Shoes for children	38.212	51.265	49.820	38.232	1.423	19.113**	27.010***
	(3.048)	(4.161)	(5.135)	(4.833)	(7.538)	(8.038)	(9.240)
Charcoal	48.693	8.502	7.367	35.510	25.961***	-19.141***	-17.952**
	(5.406)	(1.002)	(1.370)	(2.691)	(6.292)	(6.710)	(7.713)
Firewood	7.104	2.053	13.569	3.445	0.437	-1.894	12.732***
	(1.303)	(0.892)	(2.524)	(0.615)	(2.098)	(2.237)	(2.572)
Rent	14.055	1.758	7.120	20.323	-0.122	-7.986	-6.684
	(5.251)	(0.814)	(4.079)	(5.869)	(10.185)	(10.861)	(12.485)
Kerosene	7.875	7.553	11.298	6.223	-1.036	-0.110	5.986*
	(2.318)	(1.270)	(2.806)	(1.066)	(2.773)	(2.957)	(3.400)
Public transportation	222.377	74.970	61.577	93.657	118.477***	-35.828*	-26.421
	(16.752)	(8.974)	(6.937)	(6.424)	(18.227)	(19.543)	(22.343)

Table 63: Non-food expenditure *Cont.*

Oil for transportation	73.959	4.092	12.635	27.573	66.831***	-28.397	-8.980
	(17.970)	(1.730)	(6.540)	(8.237)	(22.197)	(23.800)	(27.208)
Phone top-ups	148.689	39.194	74.704	83.586	55.901***	-50.767***	-32.544**
	(10.084)	(5.169)	(9.227)	(6.149)	(13.094)	(14.087)	(16.050)
Internet	7.615	1.272	9.483	3.688	-2.992	-2.189	5.949
	(4.689)	(0.548)	(2.110)	(0.817)	(3.935)	(4.233)	(4.823)
Medicines	18.473	2.865	4.712	8.413	4.784	-6.768	-5.095
	(2.921)	(0.808)	(0.799)	(2.457)	(4.285)	(4.612)	(5.252)
Fees for doctorsdoct	8.767	1.520	0.521	6.250	4.395	1.724	-0.189
	(2.210)	(0.785)	(0.203)	(2.305)	(3.232)	(3.479)	(3.962)
Fees for hospitals	5.469	5.009	0.249	6.567	0.402	0.390	-4.941
	(1.752)	(1.392)	(0.156)	(2.934)	(3.954)	(4.266)	(4.846)
Fees for healers	7.765	5.252	4.764	1.286	6.237**	0.271	-1.830
	(3.320)	(1.940)	(3.255)	(0.574)	(3.112)	(3.358)	(3.814)
Total non-food expenditures	899.018	461.836	613.739	544.147	355.840***	-135.003**	43.448
	(43.441)	(24.796)	(39.973)	(25.096)	(56.710)	(58.859)	(69.574)

Note: * 0.1 ** 0.05 ***0.01. Columns 1 to 4 show the post-treatment unconditional averages of the outcome variables. Columns 5 to 7 show, respectively, the average effect of the CASU alone, the HGSF alone and of the combined treatments.

Operational performance of programmes

This subsection is dedicated to the operational performance of the three treatments. Questions are related to how the programmes were implemented and how they were received by their beneficiaries. The findings have a merely descriptive nature and may help the programme implementers improve the way the interventions are delivered. For instance, Table 64 has some descriptive statistics for implementation modalities of the CASU programme in the CASU group alone and in the combined treatment groups. The average time of participation in the CASU programme is between 3.6 and 3.8 years, against a formal duration of the project of 4.5 years. In the previous six months, follower farmers attended the CA trainings organized by lead farmers in the demonstration plots between two and three times. For three-quarters of the sample it is the husband who attends the training. For the remaining one-quarter, which coincides with the share of female-headed households in the sample, the wife attends. Between 80 and 90 percent of households encountered no challenges in taking part in the programme, while 16.3 percent of households in the combined group lament an inadequate frequency of the demonstrations.

Table 64: CASU operational performance feedback

	CASU	HGSF+CASU
Length of participation (years)	3.892	3.635
	(0.205)	(0.176)
Times attended in six months	1.881	2.979
	(0.100)	(0.127)
Husband attended	0.781	0.774
	(0.022)	(0.025)
Wife attended	0.194	0.181
	(0.021)	(0.023)
No challenges	0.919	0.806
	(0.014)	(0.023)
Unclear demonstration	0.031	0.031
	(0.009)	(0.010)
Infrequent demonstrations	0.050	0.163

Note: Column one shows indicators for the MA treatment in the HGSF group. Column two shows indicators for the MA treatment in the combined HGSF+CASU group. Standard errors are shown in parentheses.

Table 65 shows results for the market access (MA) component of the HGSF programme. Households declare they have been benefiting from market access from three to three and a half years, signaling a reasonably stable participation. Between 58 and 59 percent of beneficiaries declare they have received instructions on the quantity and quality of the produce they were supposed to deliver to the cooperative. Around 70 percent of respondents declare that payments by the client were made on time. Eighteen percent of the time, farmers in the HGSF group saw the produce turned down due to deficiencies in the specified quality requirements. The share of those turned down for not meeting the quality requirements is one in three in the combined treatment group. Around 70 percent of the respondents declare that they would be able to meet extra demand if their cooperative asked them to produce more. In the HGSF group, almost half the respondents encountered no major challenges under the programme, 18 percent of them say that the purchasing price of pulses is set too low, while 22.5 percent complain of collection points being too far from their farm. In the combined group, almost half of the respondents in the sample encountered no major challenges with how the pulses procurement was applied, while one-quarter of them feel that collection points are hard to reach.

Table 65: Market access operational performance feedback

	HGSF	HGSF+CASU
Length of treatment	2.876	3.750
	(0.130)	(1.343)
Received instructions	0.587	0.692
	(0.030)	(0.133)
Paid on time	0.739	0.692
	(0.026)	(0.133)
Turned down	0.187	0.333
	(0.023)	(0.142)
Met demand	0.694	0.667
	(0.028)	(0.142)
No challenges	0.486	0.375
	(0.048)	(0.183)
Low prices	0.180	0.000
	(0.037)	(.)
Expensive to reach collection point	0.225	0.250
	(0.040)	(0.164)

Decision-making

The following section is dedicated to intra-household decision-making aspects and power dynamics. Households were asked who usually takes decisions on a series of issues, such as agricultural inputs, marketing of the produce, child education, etc. We analyse here the share of households for which the head of the household takes the decision (upper panel of Table 66) and the share for which the wife takes the decision.[16] In the former case, the power dynamics concern the head-spouse relationship regardless of gender, while the latter case considers the power dynamics between wife and husband, regardless of headship. Decisions around the use of farm inputs and the type of crops to be grown are taken by the head in almost 90 percent of the cases, regardless of the group. For marketing decisions, the share of households where decisions are taken by the head is lower in the HGSF group compared with the CASU group and the share of households where marketing decisions are taken by the wife is higher for the HGSF group compared with the CASU group. A similar pattern can be observed for decisions regarding child labour and child education; in the HGSF there is a higher share of households in which the wife decides on these issues. In terms of impacts, we note that CASU alone and HGSF alone have no major impacts on the intra-household decision-making power distribution except for decisions concerning child education. The CASU programme is associated with an increase in the share of households in which such decisions are taken by the head of household and a reduction of households in which the wife decides on these issues. In the HGSF group the pattern is reversed, as we see an increase in the share of households in which wives decide on child education.

[16] The full set of choices for each decision was Head, Wife, Husband, Son/Daughter, Niece/Nephew, Father/Mother, Brother/Sister, Son/Daughter-in-law, Parent-in-law, Grandchild, Grandparent, Other.

Table 66: Decision-making

	CASU	HGSF	Both	Control	CASUvsCtrl	HGSFvsCtrl	BothvsCtrl
Head							
Agricultural inputs	0.928	0.885	0.957	0.874	0.007	-0.004	0.056***
	(0.010)	(0.012)	(0.009)	(0.009)	(0.016)	(0.017)	(0.019)
Crop type	0.926	0.871	0.950	0.849	0.034**	0.031*	0.077***
	(0.010)	(0.013)	(0.010)	(0.010)	(0.017)	(0.018)	(0.021)
Marketing	0.916	0.825	0.948	0.838	0.036*	-0.018	0.095***
	(0.010)	(0.014)	(0.010)	(0.010)	(0.018)	(0.020)	(0.022)
Major expenses	0.872	0.768	0.896	0.803	0.010	-0.009	0.077***
	(0.012)	(0.016)	(0.014)	(0.011)	(0.021)	(0.023)	(0.026)
Child education	0.881	0.747	0.911	0.795	0.069***	-0.055**	0.126***
	(0.012)	(0.017)	(0.013)	(0.011)	(0.022)	(0.024)	(0.026)
Child labour	0.886	0.774	0.918	0.791	0.083***	0.004	0.100***
	(0.012)	(0.016)	(0.013)	(0.011)	(0.021)	(0.023)	(0.026)
Wife							
Agricultural inputs	0.041	0.089	0.024	0.070	-0.014	0.014	-0.035**
	(0.007)	(0.010)	(0.007)	(0.007)	(0.014)	(0.015)	(0.017)
Crop type	0.047	0.081	0.035	0.092	-0.032**	-0.016	-0.057***
	(0.008)	(0.010)	(0.008)	(0.008)	(0.015)	(0.016)	(0.018)
Marketing	0.058	0.132	0.035	0.099	-0.023	0.026	-0.064***
	(0.009)	(0.013)	(0.009)	(0.008)	(0.017)	(0.018)	(0.020)
Major expenses	0.097	0.189	0.085	0.134	-0.007	0.020	-0.060**
	(0.011)	(0.015)	(0.013)	(0.010)	(0.020)	(0.022)	(0.024)
Child education	0.082	0.184	0.067	0.149	-0.073***	0.052**	-0.104***
	(0.010)	(0.015)	(0.012)	(0.010)	(0.020)	(0.022)	(0.024)
Child labour	0.083	0.172	0.061	0.151	-0.078***	-0.000	-0.086***
	(0.010)	(0.014)	(0.011)	(0.010)	(0.020)	(0.022)	(0.024)

Note: * 0.1 ** 0.05 ***0.01. Columns 1 to 4 show the post-treatment unconditional averages of the outcome variables. Columns 5 to 7 show, respectively, the average effect of the CASU alone, the HGSF alone and of the combined treatments.

6. Discussion and conclusions

This impact evaluation is based on one wave of post-treatment data and is characterized by a four arms design. This complex design is required to capture the impacts of the programmes analysed, both in isolation and in combination with each other. The study represents a contribution to the nascent but growing efforts to generate evidence that captures the multifaceted implications of social and productive support policies. More specifically, it is an attempt to shed light on the benefits of synergies that may accrue from increasing coherence between social protection and agricultural programmes aimed at the same population. A recent literature review on agricultural and social protection interventions confirms the relative scarcity of multiple treatment arm analysis and of studies on coherence between programmes (Veras Soares *et al*., 2017).

The CASU programme meets its own stated objectives of stimulating adoption of conservation technologies and, through this, boosting farm income and improving the food security situation in the household. In practice, the programme increases farm production and food security without significant effects on schooling. Harvests increase for virtually all crops (except for beans) and we also find robust evidence of increased livestock accumulation and production of livestock by-products. CASU also raised revenues from crop sales and market participation of beneficiaries. The programme had no effects on school attendance or drop-out rates. In terms of children's time allocation, it increased the time dedicated to on- and off-farm activities, but also time spent in schooling and studying activities. As to the FNS indicators, the CASU programme is associated with improved children's and women's dietary diversity, as well as consumption – both from purchases and from own production – of maize and other crops.

Zambia's HGSF programme pursues both a social protection objective of improving nutrition and educational outcomes by providing meals to primary school children and an income generation objective by securing a market for legumes for smallholders. While the meals component covers all the schools present in a district, food procurement through WFP's P4P programme benefits only the few hundred farmers in each district that satisfy the demand for pulses from the schools in that district.

The findings of this report show that the school meals meet their objective of improving the dietary diversity of school-going children, while also improving the diet of other household members through probable spillover effects, as shown by the increase in the dietary diversity scores for women. Meals also contribute to attracting and keeping children in school, as shown by the increase in attendance rates and the reduction of drop-out rates, as well as the improvements in literacy and grade progression. The improvements in food security, nutrition and educational outcomes induced by the school meals, besides being sizable for the average beneficiary, concern the vast majority of children in a district and have the potential to trigger long-term development processes through human capital improvements, specifically in health and education.

The public food procurement implemented through the WFP's P4P initiative grants a secure access to the market for pulses to a selected group of smallholders organized in cooperatives. When analysing the impacts of the HGSF programme we need to bear in mind that both the school meals and the purchase of pulses by WFP are expected to have a direct or indirect influence on the outcomes considered here. This is the case, for instance, for educational and food security indicators,

which are directly affected by the school meals but can also be affected by the local purchases of pulses, through the income and resource allocation channels. Other outcomes can be expected to be influenced by only one of the components of the HGSF programme. Thus, it is reasonable to exclude any influence of the school meals in the case of farm production outcomes. When we speak of the impact of HGSF in the production domain we are actually referring to the impact of the market access promoted by the local purchase component.

With this caveat in mind, we comment first on the impacts of HGSF in the production domain and then in the FNS and educational domains. We illustrate the pattern of impacts and then offer explanations for the observed results in light of the theory of change.

Our findings suggest that providing market access for legumes to farmers does lead to an increase in their production and sales, leading us to conclude that the HGSF programme meets its strictly defined objectives of creating a market for legumes and increasing revenues from these crops. However, if we broaden the picture and look at the results of HGSF's local purchases on the farm-household economy as a whole, the evidence suggests that the stimulus for increased beans production comes with a number of unintended consequences. The HGSF programme increases the share of beans growers and sellers as well as revenues from sales of beans. However, as a consequence, a smaller number of farmers grow maize and the average amount of maize harvested drops. The harvest of other crops is also reduced. The HGSF programme reduces herd size and the share of farmers owning any livestock. Gross income, which includes gross revenues from crops, livestock, wages and NFBs, is also reduced in the HGSF group, mainly as a result of a reduction in the livestock and wage income. Hence, restricting attention to the domain of farm production, this pattern of results suggests that the HGSF programme is inducing a reallocation of resources within the farm economy. The extra demand for pulses may be providing an incentive to farmers to reallocate land, labour and other resources from the livestock sector to the crop sector and, within that sector, from the production of maize to the production of beans. The revenues forgone by moving away from other crops (especially maize, Zambia's staple crop) and from livestock production are not compensated for by the increase in beans revenues, as shown by the reduction in total gross income. This begs the question of why farmers are persistently privileging beans in their crop and livelihood choices. One possible reason may be that farmers may be prioritizing safer but lower income from P4P beans purchases, although maize has a safe market too. In fact, the Food Reserve Agency (FRA), a governmental facility aimed at stabilizing maize prices and ensuring essential food supply, also buys maize from smallholders. But while the HGSF programme sets beans prices in advance, the FRA fixes maize prices after harvest, which makes the HGSF purchases a slightly safer market option.

We now consider the impacts that HGSF – in terms of both school meals and the local purchase of pulses – has on food security and educational outcomes. The P4P is the interface for farmers who supply food for the HGSF programme. Usually the crops supplied by farmers to P4P are used to prepare the meals in the district schools where farmers reside. Hence, the smallholder households supplying the food also benefit from the school meals by sending their children to the schools covered by the programme. While we observed that, on their own, the school meals have a positive impact on both FNS and educational outcomes, this was not the case when we examined the effects of the HGSF programme in its entirety, including its local purchases component. This finding lends support to the idea that the local purchase of legumes through P4P may be having unintended

detrimental impacts on FNS and education. In particular, HGSF decreased dietary diversity (for both women and children) and increased food insecurity, as measured by the FIES indicator. It has no effects on drop-out rates or school attendance among primary-school children.

These detrimental impacts may be working through three possible channels: income; consumption from own production; and time allocation. The effect on the income channel starts from the observation that HGSF is associated with a reduction in total gross income. This may explain why HGSF farmers reduced their spending on food, with negative impacts on FNS. It could also help explain why HGSF farmers cut down on their spending on schooling (expenses for transport, uniforms, etc.), thereby nullifying the positive effects observed for the provision of school meals on educational outcomes. In fact, we find evidence of HGSF farmers significantly reducing both food expenditure and educational expenditure.

Another channel that may explain the negative impacts of HGSF on food security indicators is the consumption from farmers' own production. We find that the programme is associated with reduced consumption of own-produced maize and livestock, while increasing the consumption of own-produced beans. Moving away from consumption of the maize staple towards beans may partly explain the deterioration of the FNS indicators.

Decisions on children's time allocation is a third possible channel through which the positive impacts of school meals on educational indicators could be cancelled out. However, we do not find evidence that children are sacrificing their school and study time for activities such as work or chores. Primary-school children in HGSF households do reduce the time they spend on activities on- and off-farm, but with no impacts on time spent on schooling activities.

One key question that clearly emerges is whether the farm households currently targeted by the HGSF programme are in a position to answer to the extra demand from the public food procurement component, without sacrificing other sectors of farm production (e.g. other crops, livestock activities) or compromising their own welfare (e.g. food security, schooling). The first implication here is that when deciding who the designated beneficiaries of the purchases should be, the programme planners should target smallholders who are already producing a surplus in the required crops or who have the productive potential to increase production and meet the extra demand. Farmers with limited capacity should be supported with targeted interventions that can enable them to unleash their potential.

This leads us to consider the possible presence of several supply-side constraints that designated beneficiaries of HGSF may encounter in trying to meet the extra demand generated by the programme. Such constraints faced by smallholders include: limited access to land, variable inputs, technology and knowledge; limited market information; and limited liquidity – beyond the already mentioned market access constraints due to high transaction costs. These constraints should be taken into account at the planning stage of the programme. If supply-side constraints are not eased, it may lead to resource reallocation within the farm economy and to detrimental effects in the welfare sector (e.g. FNS, schooling) (Gelli *et al*., 2015).

In fact, our evidence shows that HGSF farmers do not increase the use of land. Instead, land is reallocated from maize and other crops to beans production. This suggests that farmers probably face constraints in access to resources. Easing access to land may allow them to allocate more land and other resources to meet the extra demand from HGSF, without having to reduce the land

dedicated to the production of maize and other crops. If the land constraint cannot be relieved and farmers have no choice but to reallocate resources, there are two ways to make sure that the increased revenues from beans sales more than compensate for the forgone earnings from maize. For this to happen, at least one of the two factors that determine beans revenues – namely, quantities and prices – would need to increase so as to compensate for the foregone maize revenues. Given the land constraint, an increase in beans production that compensates the farmer for a reduction in maize production[17] necessarily implies an increase in beans yield through increased use of fertilizers or more capital-intensive and labour-saving technologies, such as tractors and other mechanized tools. The second way to increase beans revenues to compensate for the reduction in earnings from the sale of maize would require the HGSF programme to offer higher prices to farmers for beans. In Zambia, maize yields in terms of output per hectare are four times as large as bean yields; however, the price for beans offered to farmers by P4P is not four times as large as the price for maize.

Since current HGSF beneficiaries do not seem to be in a position to meet the extra demand for legumes from HGSF without reallocating resources or compromising their welfare, it is necessary to consider linking the HGSF programme to complementary productive interventions in order to ease the above-mentioned supply-side constraints and to reconsider the inner coherence of the HGSF programme.

HGSF programmes should consider how best to link smallholders to complementary interventions that address such constraints (FAO, 2018). These supply-side support activities may be built into the HGSF programme or may result from combining HGSF with other livelihood support programmes, such as the CASU project or other agricultural programmes currently operating in Zambia. The smallholders supplying the food may be supported through subsidized adoption of adequate production technologies that will allow them to reduce costs and make production more profitable or less risky. Supply-side support may include provision of inputs such as seeds and tools, training on farming, and food conservation and marketing techniques. HGSF farmers who benefit from the public food procurement could draw great benefits from a complementary intervention consisting of access to subsidized fertilizers or use of mechanized tools, to allow them to increase beans yields. This may place these farm households in a better position to respond to the extra demand from HGSF's food procurement, without having to trade off productive or welfare decisions. Provision of insurance or access to cash grants or credit through vouchers can also alleviate some supply-side constraints that are often binding for smallholders due to incomplete or missing insurance and credit markets.

In terms of the inner coherence of the HGSF programme, we should keep in mind that smallholders in Zambia are not running farming firms in a context of well-functioning markets, where they would be able to make decisions on production independently from those affecting their consumption. Smallholders are farm households, whose production, consumption and welfare decisions are interdependent. Choices made in one domain affect the others, which is why we may be seeing negative impacts on HGSF households' welfare and consumption due to changes in their production

[17] Here we focus discussion on maize, which is by and large the most important crop for Zambian farmers, but the argument applies to all crops that suffer a reduction in their relative importance in the crop portfolio due to the incentives to produce more beans.

decisions induced by the programme's local procurement of legumes. A crucial implication of these findings is that productive support from the P4P intervention and the school meals should not operate in isolation but be coordinated, so that they do not neutralize each other's effects on certain outcomes. In our specific scenario, the problem is how to continue supporting income-generating activities through local purchases without households having to sacrifice some aspects of welfare. This observation is also true when it comes to linking the HGSF programme with complementary programmes supporting production. Increased coherence among programme components or between separate programmes targeted simultaneously at the same households is required to make sure they reinforce each other's effects or mitigate unintended negative impacts on key outcomes. Coherence within and between programmes is not automatic. It is not simply obtained by accidental overlap of two interventions in a given area. Programme coherence requires intention, which is greatly facilitated by ensuring there is multistakeholder management and coordination from planning to implementation stage.

Other issues that may help us to understand why HGSF farmers take certain decisions are related to the programme's design, implementation modalities and operations. A quantitative impact evaluation, while giving an accurate picture of the magnitude of programme impacts on a range of outcomes, can only hint at the reasons behind a programme's impacts on those outcomes. How contract prices fixed in advance compare with market prices at the moment of purchase, whether inflation expectations are taken into consideration when fixing the forward price, how cooperative-farmer price arrangements work, as well as questions concerning the distribution of profits, timing and predictability of contracts and payments, and the like, could be better answered by further qualitative investigation.

The combination of the HGSF and CASU programmes has had positive impacts on a wide number of farming and FNS outcomes.[18] In particular, combining the CA training and productive support with the HGSF programme led to increased crop production and sales. For some crops, the improvements were larger than from CASU alone, hinting at possible synergic effects of the combined programmes. The beneficiaries of the combined treatment accumulated more livestock and produced more livestock by-products – sometimes more than those in the CASU-only arm. Farm households in the HGSF+CASU arm had higher revenues from crop sales than households in either standalone programme treatment. As a result, total gross income also increased considerably more in the combined group relative to the CASU-only group. The more intense farming activity is also reflected in the increased use of crop inputs and other services. In terms of crop diversification, beneficiaries of the combined programmes show better results than in either standalone programme. We also found evidence of increased adoption of CA techniques in the combined group, to a larger extent than among CASU-only farmers. Combining CASU with the HGSF programme also led to improved women's and children's dietary diversity and increased consumption of maize (and sweet potatoes) – more than among CASU-only farmers.

Alone, the HGSF programme had mixed positive and negative FNS effects, but when combined with CASU, effects often turned positive. This may be explained either in terms of a prevailing influence of

[18] Here, too, when we refer to impacts in the production domain of HGSF, we are referring to its food procurement component, as this is the one that has a direct effect on production, while the school meals do not.

the CASU treatment or of complementarities triggered by the combination of both programmes. Disentangling these competing explanations will require more qualitative investigations that focus on the reasons behind certain household behaviours and shed light on the processes that govern programme implementation.

With regard to education, the combination of the HGSF and CASU programmes produced some negative impacts for primary school-aged children. In particular, it reduced the share of children attending school and passing the grade. We also document a reduction in the number of days attended in the preceding two weeks.

We propose several alternative explanations for these negative educational impacts. The first relates to the time allocation channel, hypothesizing that commitment to the productive interventions (HGSF, CASU) may be such that it leads farmers to sacrifice some aspects of household welfare by increasing children's involvement in farm activities. This may trigger conflicting interactions between the productive (local purchases, CASU) and social protection (school meals) components of the two programmes. However, we do not find sufficient evidence to support this hypothesis. In particular, there is no evidence of greater work involvement of children, although the number of daily hours dedicated to schooling does reduce significantly. A second hypothesis – that the negative effects on schooling occur through the income channel – can be excluded, since total gross income increases more in the combined group than in the other treatment arms and there is no evidence of reduced spending on schooling either. This may again suggest that income growth alone may be insufficient to translate into increased schooling or improvements in other realms of household welfare. The third explanation for the negative impacts on schooling relates to the intrahousehold bargaining power channel. Women's empowerment and control over income and resources may play a role in how income is spent. Previous research has found that when women have more control over income, they are more likely to spend it on improving their children's schooling and feeding (Idrissu *et al.*, 2017). Our data show some evidence that women's decision-making power is significantly lower in the combined group relative to the rest of the population. Women's contributions to decision-making in the household could go some way towards curbing some of the unintended negative of the programmes.

Overall, each programme or programme component considered in the study fulfils its own stated objectives, with the school meals improving primary school-aged children's food security and educational outcomes, the public food procurement increasing production and sales of pulses, and the CASU programme stimulating adoption of CA and boosting farmers' incomes. More needs to be done to increase coherence within and between programmes by ensuring that the combination of components of the same programme or of two separate programmes does not produce conflicting impacts on the other intended outcomes. This could be done by refining the design and implementation of the programmes to make them more sensitive to the objectives of other programmes, so that support for income-generating activities does not come at the cost of achieving food security or educational outcomes. Careful planning at the programme design and implementation stages is vital to enhance the impact of social protection and agricultural interventions on the beneficiaries' lives. This may sometimes require combining an existing programme with a complementary package or with another programme to ensure positive impacts while avoiding undesirable side effects. The use of common registries of beneficiaries for joint targeting should also be encouraged as a tool for increasing coherence.

References

Alemu A.E. & Adesina J.O. 2017. *In search of rural entrepreneurship: Non-farm household enterprises (NFEs) as instruments of rural transformation in Ethiopia*. African Development Review, 29(2): 259–271.

Asfaw, S., Pickmans, R., Alfani, F. & Davis, B. 2016. *Productive impact of Ethiopia's Social Cash Transfer Pilot Program*me. PtoP project report. Rome, FAO - February 2016

Ballard T.J., Kepple A.W. & Cafiero C. 2013. *The Food Insecurity Experience Scale: Development of a global standard for monitoring hunger worldwide*. Technical Paper. Rome, FAO.

Berhane, G., Hoddinott, J., Kumar, N. & Taffesse, A.S. 2011. *The impact of Ethiopia's Productive Safety Nets and Household Asset Building Program: 2006-2010*. International Food Policy Research Institute.

Berhane, G., Devereux, S., Hoddinott, S., Hoel, J., Roelen, K., Abay, K., Kimmel, M., Ledlie, N. & Woldu, T. 2015. *Evaluation of the Social Cash Transfer Pilot Program, Tigray Region, Ethiopia*. Endline Report.

Bhutta, A., Das, J.K., Rizvi, A., Gaffey, M.F., Walker, N., Horton, S. *et al*. 2013. *Evidence-based interventions for improvement of maternal and child nutrition: What can be done and at what cost?* Lancet 382(9890): 452–477.

Brick, K., Visser, M. & Burns, J. 2012. *Risk aversion: Experimental evidence from South African fishing communities.* American Journal of Agricultural Economics 94(1): 133-152.

Christoplos, I. 2010. *Mobilizing the potential of rural and agricultural extension*. Office of Knowledge Exchange, Research and Extension, FAO, Rome.

Coates, J., Swindale A. & Bilinsky P. 2006. *Household Food Insecurity Access Scale (HFIAS) for measurement of household food access: Indicator Guide (v. 2)*. Food and Nutrition Technical Assistance, Academy for Educational Development, Washington DC.

Daidone, S., Davis, B., Dewbre, J., Miguelez, B., Niang. O. & Pellerano, L. 2017. *Linking agriculture and social protection for food security: The case of Lesotho.* Global Food Security 12: 146-154 .

Daidone, S., Davis, B., Handa, S. & Winters, P. 2017. *The household and individual-level economic impacts of cash transfer programs in sub-Saharan Africa*. Synthesis Report, PtoP project report. Food and Agriculture Organization, Rome.

Devereux, S., Gilligan, D., Hirvonnen, K., Hoddinott, J., Roelen, K. & Taffesse, A. 2016a. *Impact evaluation of the UNICEF Social Cash Transfer Pilot Programme in Oromia and SNNP regions, Ethiopia*. Inception Report. Unpublished manuscript.

Devereux, S., Gilligan, D., Hoddinott, J., Jilani, A., Kebede, D., Ledlie, N., Roelen, K. & Taffesse, A. 2016b. *Impact evaluation of the UNICEF Social Cash Transfer Pilot Programme In Oromia and SNNP regions, Ethiopia*. Baseline Survey Report. Unpublished manuscript

FAO. 2002. *The state of world fisheries and aquaculture*. Fisheries Department, FAO, Rome.

FAO. 2011. *Guidelines for measuring household and individual dietary diversity*. FAO, Rome.

FAO. 2015. Food and Agriculture Organization of the United Nations [online]. Rome. [Cited June 2020]. (also available at http://www.fao.org/ag/ca/index.html).

FAO. 2016. *Compendium of indicators for nutrition-sensitive agriculture*. FAO, Rome.

FAO. 2017. *Nutrition-sensitive agriculture and food systems in practice: Options for intervention*. FAO, Rome.

Gertler, P.J., Martinez, S., Premand, P., Rawlings, L.B. & Vermeersch, C.M.J. 2011. *Impact evaluation in practice* (second edition). Inter-American Development Bank and World Bank, Washington DC.

Hall, R., Van Koppen, B. & van Houweling, E. 2013. *The human right to water: the importance of domestic and productive water rights.* Science Engineering Ethics, 20(4): 849–866.

Hoddinott, J., Headey, D. & Dereje, M. 2015. *Cows, missing milk markets, and nutrition in rural Ethiopia.* Journal of Development Studies, 51: 958-975.

Iddrisu, A., Danquah, M., Quartey, P. 2017. *Gender bias in households' educational expenditures: does the stage of schooling matter?.* Conference: 3rd School of Social Sciences International Conference, University of Ghana.

Kassam A.H., Mkomwa S. & Friedrich T. 2017. *Conservation Agriculture for Africa: Building resilient farming systems in a changing climate*. CABI, Wallingford, UK.

Kennedy G., Berardo A., Papavero C., Horjus P., Ballard T., Dop M.C., Delbaere J. & Brouwer I. 2009. *Proxy measures of household food consumption for food security assessment and surveillance: Comparison of the household dietary diversity and food consumption scores.* Public Health Nutrition 13(12): 2010–2018 doi:10.1017/S136898001000145X.

Masset, E., Haddad, L., Cornelius, A. & Isaza-Castro, J. 2012. *Effectiveness of agricultural interventions that aim to improve nutritional status of children: A systematic review.* British Medical Journal 344: d8222.

McDonald, J.H. 2008. *Handbook of biological statistics*. Sparky House Publishing, Baltimore, Maryland.

Ministry of Agriculture of Ethiopia. 2014. *Productive Safety Net Program Phase IV.* Programme Implementation Manual.

Prifti E., Estruch E., Daidone S. & Davis B. 2018. *How differences in cash transfer sizes affect work allocation decisions: Evidence from cross country comparison in SSA.* LABOUR: Review of Labour Economics and Industrial Relations 32(3): 395-426.

Quisumbing, A.R. & de La Brière, B. 2000. *Women's assets and intrahousehold allocation in rural Bangladesh: Testing measures of bargaining power*. IFPRI Discussion Paper 86.

Ruel, M.T. & Alderman, H. 2013. *Nutrition-sensitive interventions and programs: How can they help to accelerate progress in improving maternal and child nutrition?* Lancet 33(9891): 536-551.

Schubert, B. 2015. *Design and logical framework of the Social Cash Transfer Pilot Programme in Oromia and SNNPR implemented by MoLSA/BoLSAs as part of the Productive Safety Net Programme, Phase 4.* Report commissioned by UNICEF.

Thomas, D., Strauss, J. & Henriques, M.-H. 1990. *Child survival, height for age and household characteristics in Brazil.* Journal of Development Economics 33: 197–234.

Triki T. & Faye I. 2013. *Financial inclusion in Africa*. African Development Bank (AfDB).

Veras Soares, F., Knowles, M., Daidone, S. & Tirivayi, N. 2017. *Combined effects and synergies between agricultural and social protection interventions: What is the evidence so far?* FAO, Rome.

WFP. 2014. *Ethiopia: Comprehensive Food Security and Vulnerability Analysis (CFSVA).*

World Bank. 2010. *Lessons learned from Ethiopia's Productive Safety Net Program 2005-2009.* *(*Available at http://siteresources.worldbank.org/SAFETYNETSANDTRANSFERS/Resources/EthiopiaPSNPLessonsLearnedLite.pdf).

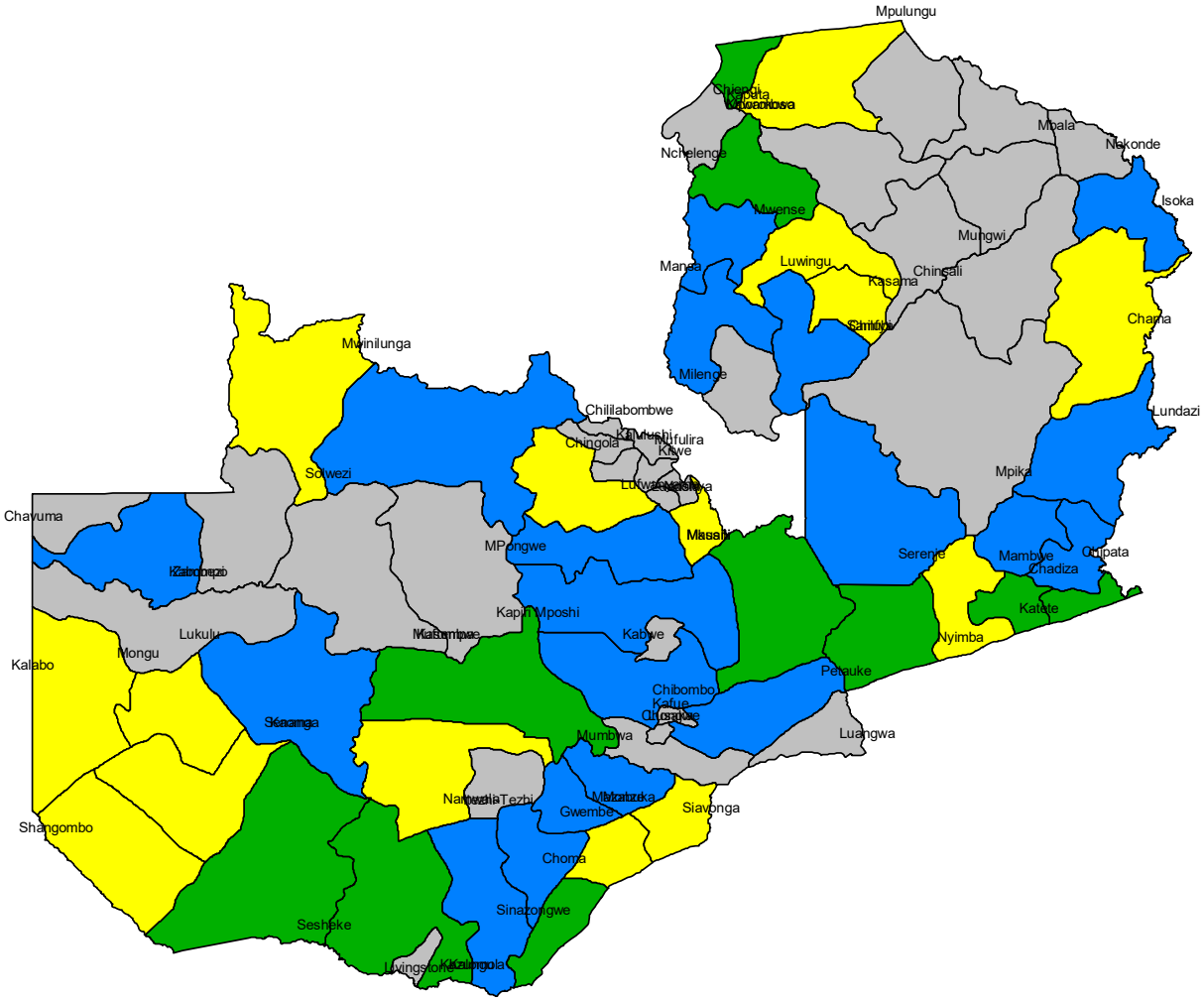
Appendix

Table 67: District coverage of interventions

School meals	P4P (->SF)	P4P (-> other)	CASU
Chadiza	Chadiza	Chadiza	Chadiza
Chama	Chinsali	Chinsali	Chibombo
Chienge	Choma	Choma	Chiengi
Chilubi	Gwembe	Kabwe	Chipata
Chirundu	Kabwe	Kalomo	Choma
Gwembe	Kalomo	Kapiri mposhi	Chongwe
Ikelenge	Katete	Katete	Isoka
Kalabo	Kawambwa	Kawambwa	Kalomo
Kaputa	Lundazi	Luwingu	Kaoma
Katete	Mansa	Mafinga	Kapiri Mposhi
Kawambwa	Mazabuka	Mansa	Katete
Kazungula	Monze	Mazabuka	Kawambwa
Limulunga	Mulobezi	Mbala	Kazungula
Luano	Nakonde	Mkushi	Lundazi
Lufwanyama	Petauke	Mkushi	Mafinga
Luwingu		Monze	Mambwe
Masaiti		Mumbwa	Mansa
Mkushi		Nakonde	Mazabuka
Mongu		Pemba	Mkushi
Mulobezi			Monze
Mumbwa			Mpongwe
Mwandi			Mumbwa
Mwansabombwe			Mwense
Mwinilunga			Nyimba
Nalolo			Petauke
Namwala			Samfya
Nsama			Serenje
Nyimba			Sesheke
Petauke			Sinazongwe
Senanga			Solwezi
Sesheke			Zambezi
Shangmbo			
Shibuyunji			
Siavonga			
Sikongo			
Sinazongwe			
Sinda			
Vubwi			

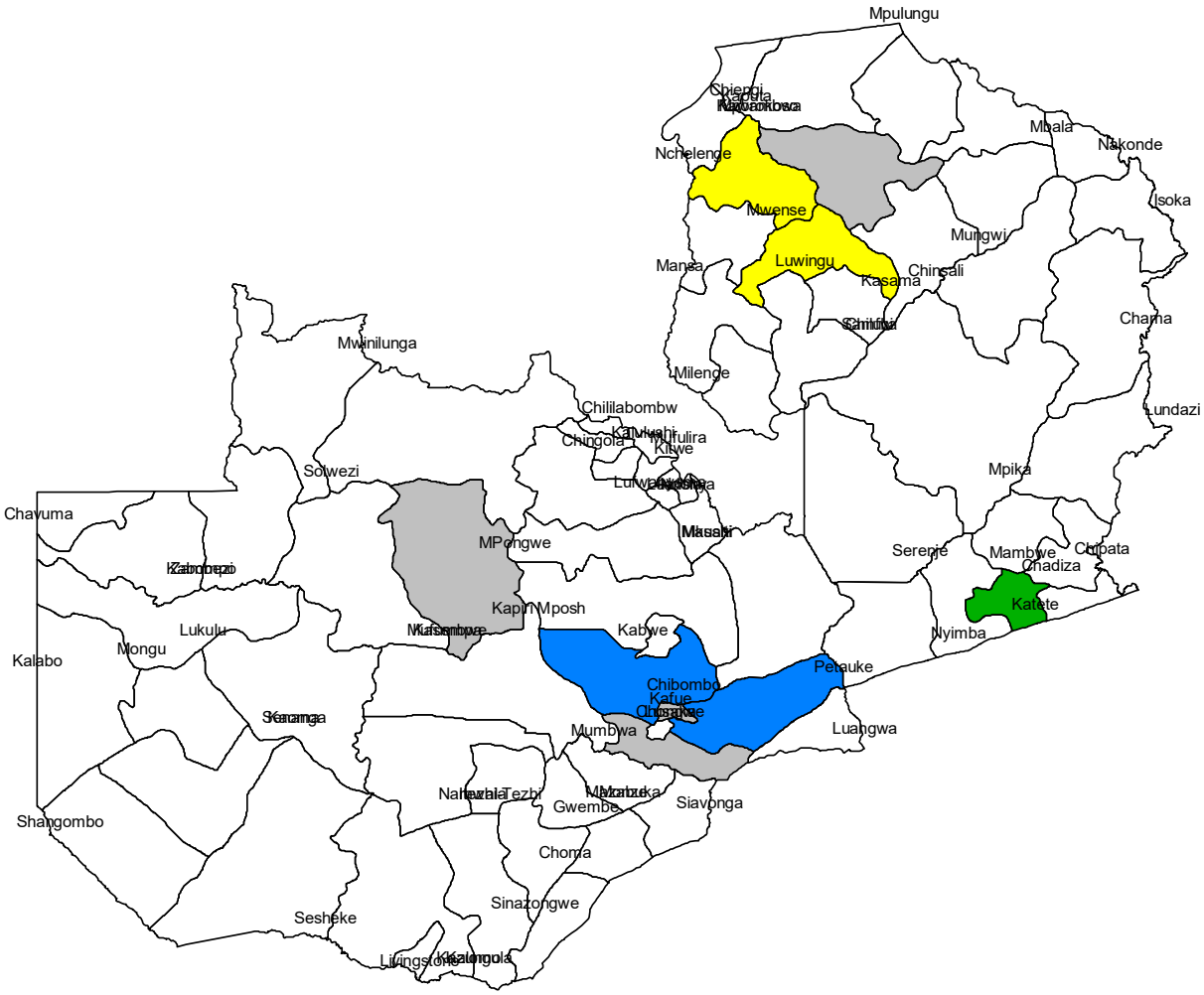
Note: Column 1 shows the districts covered by school meals, Column 2 shows districts where P4P buys for HGSF, Column 3 shows districts where P4P buys for other social protection uses and Column 4 shows districts covered by CASU.

Figure 8: District coverage of HGSF and CASU



Note: Yellow indicates coverage by HGSF only (either school meals or P4P), Blue indicates districts covered only by CASU, Green indicates districts covered by both HGSF and CASU and Grey indicates districts not covered by either of these programmes. The map is out of date, as it includes only 72 districts. As a result of splitting old districts into new ones, Zambia now includes 117 districts.

Figure 9: District coverage of the study



Note: Yellow indicates districts included in the study covered by HGSF only, Blue indicates districts covered only by CASU, Green indicates districts covered by both programmes, while Grey indicates control districts. Uncoloured districts are those not included in the study.

Table 68: Districts and number of CASU farmers per district

PROVINCE	DISTRICT	NUMBER OF CASU FARMERS
Central	Chibombo	8 551
Central	Kapiri Mposhi	10 330
Central	Mkushi	5 093
Central	Mumbwa	10 394
Central	Serenje	8 477
Central	Mpongwe	7 422
Eastern	Chadiza	3 141
Eastern	Chipata	10 122
Eastern	Katete	15 671
Eastern	Lundazi	6 584
Eastern	Mambwe	1 742
Eastern	Nyimba	11 691
Eastern	Petauke	13 594
Luapula	Chiengi	958
Luapula	Kawambwa	1 834
Luapula	Mansa	6 004
Luapula	Mwense	3 136
Luapula	Samfya	4 650
Lusaka	Chongwe	16 732
Muchinga	Isoka	2 770
Muchinga	Mafinga	5 472
Northwestern	Solwezi	1 445
Northwestern	Zambezi	2 586
Southern	Choma	14 366
Southern	Kalomo	12 168
Southern	Kazungula	6 042
Southern	Mazabuka	11 076
Southern	Monze	12 543
Southern	Sinazongwe	2 959
Western	Kaoma	6 716
Western	Sesheke	3 265
TOTAL		**227 534**

Selection Criteria for CASU Lead and Follower Farmers

Lead Farmers

- Lead Farmer must be a Model Farmer and be able to host the main demonstration plot and take responsibility for guiding the other farmers and taking care of the project equipment and any other related materials.
- Lead Farmer must be an active resident farmer who commands respect within the community and is easily approachable by other community members.
- Lead Farmer must be selected or nominated by the Camp Agricultural Committee and approved by both the Camp Extension Officer and the Block Extension Officer.
- Lead Farmer must have enough farmland – i.e. more than 1 hectare – for expansion and training purposes.
- Lead Farmer must not be participating in another Conservation Agriculture (CA) project being implemented by any other organization.
- Lead Farmer selection priority should be given to the active and committed Follower Farmers, preferably women in camps where we have fewer women Lead Farmers.
- Lead Farmer should have no intention of moving from the camp within the next five years.
- Lead Farmer should be from a village within the camp boundaries.
- Lead Farmer should be trainable and able to train other farmers.
- More than one Lead Farmer should not be selected from the same household.

Follower Farmers

- Follower Farmer must be a small- or medium-scale farmer within the camp boundaries.
- Follower Farmer must have enough land – i.e. at least ½ hectare.
- Follower Farmer must be willing and self-motivated to participate in CA activities.
- Follower Farmer must not be participating in any CA/CF activities implemented by any other organization.
- Follower Farmer should be selected by the Lead Farmer under the supervision of the Camp Extension Officer.
- Follower Farmer must be an active resident farmer in the camp.
- Follower Farmer must be selected from within a radius of 2 km of the Lead Farmer.
- More than one Follower Farmer should not be selected from the same household.

FAO, together with its partners, is generating evidence on the impacts of coordinated agricultural and social protection interventions and is using this to provide related policy, programming and capacity development support to governments and other actors.

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