Impact Assessment of ZADT Fund Program on Agricultural Productivity, Income and Food Security in Zimbabwe:

Second Round Survey 2018

Report submitted to:

Zimbabwe Agricultural Development Trust

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Executive Summary

The Zimbabwe Agricultural Development Trust ("ZADT") provides soft loans to eligible borrowers through the ZADT's Credit for Agricultural Trade and Expansion ("CREATE") now known as the ZADT Fund for supporting smallholder agriculture in Zimbabwe. Actors in all the agricultural value chains, with the exception of tobacco and cotton, are eligible to access funding from ZADT. Eligible borrowers have been defined into categories which include Smallholder Farmers, Agro Dealers, Traders, Transporters, Processors, Wholesalers, manufacturers and contracting companies. The International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) was commissioned by ZADT to conduct a longitudinal impact assessment of the ZADT Fund in order to measure the effect of the Fund on farmer's agricultural production, asset accumulation, income, food and nutritional security. The study employed quantitative data collection techniques where the household questionnaire was used to collect information from 513 and 506 households in 2016/17 and 2017/18 respectively. The study was carried out in targeted sentinel sites where different value chains were being supported by borrowers. The borrowers accessed funds from selected financial institutions to support farmers in various agricultural activities. The sentinel sites selected for the survey included Binga, Buhera, Chiredzi, Chipinge, Mt Darwin, Murehwa, Gokwe North and Mutasa. Borrowers with active and matured facilities as well as long relationship with farmers were sampled to assess the sustainability of the intervention beyond the project life.

Impact of ZADT facility

The study results show that the program was successful in improving the welfare and income of farmers. The ZADT Fund improved smallholder farmer's access to credit, particularly for women. Approximately 52% and 44% of the farmers that obtained the ZADT credit in 2016/17 and 2017/18 respectively were females and this resonates with the Sustainable Development Goal 5 (SDG 5) of promoting gender equality and women empowerment (Ferguson, 2011). Results also show that farmers have limited access to credit from other sources. This reflects the importance of ZADT facility in addressing credit constraints among smallholder farmers. Farmers that participated in the ZADT programme had better access to extension services. In addition to government extension support services that is provided to all farmers, about 42% and 43% of farmers that participated in the ZADT programme obtained additional extension support from borrowers in the two cropping

seasons respectively. Availing extension support helps in building capacity among farmers and also improves productivity. This has spillover effects towards economic development. Access to information through extension support helps in building capacity among farmers and also improves productivity. This has spill over effects towards household welfare and economic development.

The ZADT Fund was instrumental in creating a stable, viable and guaranteed market for smallholder farmers. The introduction of new high value chains such as Michigan pea bean among smallholder farmers is very crucial. Crops sales from value chains supported by the ZADT facility contributed about 58% and 75% to total crop revenue generated in 2016/17 and 2017/18 seasons respectively. The regression results also showed that an extra dollar obtained from ZADT facility increased sugar cane and red sorghum income by 95.1% and 16.9% among participating farmers in 2018. In 2016/17 season, an extra dollar obtained from ZADT facility increases agricultural income by 110% and 55% for cereal crop and sugarcane farmers respectively. These results taken together show that sugarcane (Chiredzi) is the best performing value chains across all seasons. Banana (Chipinge), tea (Mutasa) and red sorghum (Binga) value chains performed better in terms of income generation. An additional year of borrower-farmer relationship increased income among sugarcane and Michigan pea farmers by 15% and 45% respectively in 2017/18 season. Income obtained through the borrower accounted for a greater proportion of income that was obtained from all crops sales in the two consecutive seasons. Mung beans (Mt Darwin) and Sesame are the two value chains that did not perform well in both 2016/17 and 2017/18 seasons. Sesame value chain was not functional in 2016/17 season in the selected site of Chiredzi, because Sidella Trading, the funded value chain actor, did not maintain the relationship with the farmers after the maturity of the facility therefore farmers did not sell any crops through the borrower. Again in 2017/18, Sidella Trading did not provide any credit to sesame farmers although they bought the produce. Overall, approximately 34% and 59% of the households earned more than US$2 per day from the sales that were channelled through the borrower in 2016/17 and 2017/18 respectively and this is in line with Sustainable Development Goal (SDG1) of ending poverty.

Most of the income generated from crop sales under the ZADT facility in 2016/17 (36%) and 2017/18 (28%) were used to purchase food thereby improving dietary diversity. The regression results showed that a unit increase in the initial credit leads to a 2.4% and 3.7% increase in

household dietary diversity and food consumption score respectively in 2016/17 season. In 2017/18 season, credit access increased household dietary diversity and food consumption score by 13% and 10% respectively. This argues well with the Sustainable Development Goal (SDG2) of ending hunger, achieve food security and improved nutrition and promote sustainable agriculture. Some of the farmers used the income to pay for school fees for their children. This has a positive and long-term effect on human capital development. Some farmers also reinvested income into agricultural activities (20%) and (18%) for 2016/17 and 2017/18 seasons respectively. The ability to reinvest ensures sustainability of farm enterprise. The results on women participation, enhanced food security and poverty reduction show that ZADT is contributing immensely to SDGs 1, 2 and 5 among farmers in the country.

Despite the ZADT funds' positive impact on farmers' livelihoods, the programme had some challenges. About 37% of the farmers highlighted that they encountered delays in receiving credit/inputs in both the two cropping seasons. Delays in giving farmers inputs/credit results in late planting which usually leads to yield losses, especially for rain fed cropping systems. Nearly 31% and 45% of farmers indicated that the repayment procedure and conditions were not clearly articulated to them in 2016/17 and 2017/18 seasons respectively. Lack of transparency, stringent and unclear requirements usually leads to lack of trust and has negative effects on the farmer-borrower relationship. Weather related risks and pests in particular fall army worm negatively affected crop production and productivity and this subsequently results in food insecurity.

Recommendations

The study findings indicated that the ZADT facility had a positive impact on improving agricultural productivity, incomes, livelihoods and food security of smallholder farmers. Given these positive contributions the facility needs to continue availing the credit to farmers. Policies that strengthen the functioning of agricultural credit need to be promoted. We provide the recommendations below:

i. Enhance inclusive credit access and increase volumes

There is need to continue improving inclusive credit access and increasing the amount of credit offered to farmers as well as improve market linkages opportunities for farmers who are supported by the funded agricultural value chain actors. The results showed a positive relationship between amount of credit given to farmers and crop income in the two seasons. Increasing crop incomes

might have wider economic benefits if farmers reinvest in agricultural activities. Market linkages could be improved by encouraging contractual arrangements that are beneficial to both the borrower and the farmer. Contract farming is emerging as an important form of vertical coordination in the agri-food supply chain and contributes towards improving yield and reducing production costs. Very few borrowers had written contracts with farmers. These contractual arrangements should be in the form of written contacts as they show better levels of commitment. Interventions that continue to improve credit access among women smallholder farmers are crucial. The ZADT fund should also strategically link and strengthen ISAL groups where the majority of members are women. There is need for ZADT, financial institutions, borrowers and the public extension nurture and maintaining long term relationships between borrowers and farmers to enhance sustained welfare.

ii. Financing sustainable crop and livestock enterprises

Borrowers should strive to finance crops and livestock enterprises that farmers are familiar with. The major crop and livestock enterprises that farmers are familiar and have interests include maize, sugar beans, sorghum, groundnuts, small stock and cattle. It will be easier for farmers to achieve good quality products for crops they are used to grow and this is crucial for sustainability. Some of the crops commonly grown by farmers that have potential include groundnuts and sugarbeans. There is huge demand for groundnuts and biofortified sugarbeans by processing companies in Zimbabwe, for example Cairns Foods and the ZADT facility can deliberately target these enterprises. There is scope for financing livestock enterprises for example commercial goat production and beef feeder finance schemes. However, new value chains have low risks of side marketing and off-takers usually prefer them as well as they will have secured a niche market for them. The introduction of new crops to farmers should be supported by extensive market research, extension support and market guarantee. Overall, based on income the best performing value chains in our study include banana, sugarcane, tea and sorghum and these should continue to be supported.

iii. Relevant and timely extension and farmer training

There is need for borrowers, private and public extension to continue providing extension support to farmers. All pluralistic extension methods including group and individual extension methods including ICT linked extension should be used to disseminate real time agricultural, market and

price information to farmers. Alternatively, farmers could be encouraged to form associations which would be used as a vehicle for providing training, for example ISAL groups which can be directly linked to the ZADT facility. There is need for extensive farmer training on Integrated Soil Fertility Management Practices, business management, record keeping and budgeting. In addition to general extension, there is need for both the private and public sector to provide training on financial literacy, post-harvest losses management, fall armyworm control and business entrepreneurship.

iv. Transparent and efficient costing system

There were cases in 2016/17 where farmers had to pay about 28% more than what they would have paid if they had obtained inputs directly from agro-dealers. However, in 2017/18 farmers highlighted that credit scheme was transparent and realistic. There is need to foster transparent and efficient ways of providing credit and input services to farmers at a realistic cost, such that the cost under the facility is not way above the cost of obtaining inputs directly from agro dealers. The program should strive to provide inputs at a cost that allows farmers to pay at most 15% more than the actual market price after factoring in interest, administrative and transport cost as was the case for 2017/18 season.

v. Timely disbursement of inputs (credit) and prompt payment to farmers

Though the ZADT Fund was hugely successful, farmers raised concerns about the delayed timing of the credit from the borrower regardless of the type of value chain. Timely disbursement of inputs by borrowers permits farmers to plan their cropping mix efficiently, plant in time and allocate farm resources efficiently to ensure viable farm enterprises. Furthermore, borrowers should make prompt payments to farmers after collecting the harvested crops to build farmers' confidence and trust that is necessary for sustainable relationships. Faster and cheaper electronic transfers through mobile money can also be used to ensure timely farmer payments.

vi. Participation of women and youths in the programme

The ZADT Fund was successful in addressing gender inclusivity, given that most women participated in the value chains in the two consecutive years. This resonates with the Sustainable Development Goal (SDG5) of promoting gender equality and women empowerment (UNSD, 2016; Pradhan et al., 2017; Ferguson, 2011). However, overall participation of youths in this credit

programme was limited. There is need to make deliberate efforts to promote youth participation in the agricultural programmes in order to ensure maximum productivity and continuity. ZADT fund can deliberately fund business enterprises that are pro-youth and don't require land ownership rights, for example value addition (peanut butter processing and sale), transport and aggregation, beef feeder finance schemes, aquaculture and butchery.

1 INTRODUCTION

The Zimbabwe Agricultural Development Trust ("ZADT") was established in 2010 with the objective of providing soft loans to agriculture value chain actors working with and for the benefit of smallholder farmers in Zimbabwe. The Trust aims to promote growth in primary agriculture and related value chains with the main thrust of improving food security and income for rural communities through the provision of funding for agricultural activities. This Trust was formed after the realization that access to credit plays a crucial role in the development of Zimbabwe agriculture (ZADT, 2016). The Trust established the Credit for Agricultural Trade and Expansion ("ZADT") Fund now referred to as the ZADT, in 2010 as a revolving facility for the purposes of supporting smallholder agriculture in Zimbabwe (ZADT, 2016). The facility promotes smallholder farmers through financing and facilitating market driven initiatives. ZADT Fund aims at improving food security and incomes of rural households through contributing towards the recovery and the improvement of smallholder farming sector in Zimbabwe. The ZADT channels money under the ZADT Fund to local financial institutions in Zimbabwe to on-lend to smallholder farmers and to agriculture value chain actors who demonstrate that their business operations benefit smallholder farmers in the country. These value chain actors include processors, manufacturers, agro dealers, traders, wholesalers, transporters and contracting companies. These organizations typically buy from, sell and provide services to smallholder farmers (ZADT, 2016, 2017).

The first programming phase under this facility was from January 2010 to December 2015 with the first disbursements being done in 2012. Initially three (3) commercial banks were engaged to disburse the Fund. The number of financial institutions have since been increased to seventeen (17) as at 30 September 2018 comprising eight (8) commercial banks and nine (9) microfinance institutions. The second phase started in 2016. In 2017 ZADT crafted a new five year Strategy covering the period 2018 to 2022 (ZADT, 2017). ZADT also commissioned a three-year longitudinal impact tracking study starting in 2017 and ending in 2019. The International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) was awarded the impact assessment contract and it has carried out the first and second rounds of the 3-year longitudinal study. The sentinel study aims at tracking the impact of the ZADT Fund. The second round was carried out from September 2018 to October 2018 and builds upon the first round of survey conducted in 2017.

2 OBJECTIVES

This study aimed at quantifying the impacts of the ZADT Fund on smallholder farmers and also serve as a second-round survey for the three-year longitudinal sentinel study. Specifically, the study assessed the impacts of the ZADT Fund on:

(i) agricultural (crop and livestock) productivity
(ii) asset accumulation
(iii) annual household incomes
(iv) percentage of smallholder farmers who are earning more than US$2 per day as a result of their participation in the funded value chains
(v) food and nutritional security status of target smallholder farmers.

In addition, the study also verified the extent of women empowerment as well as highlight challenges faced by the farmers. The evaluation also highlights key lessons learnt from the agricultural finance model based on experiences of the linked smallholder farmers and the funded agribusinesses. Cross inferences with data from first round survey is used extensively in the report to capture changing dynamics.

3 MATERIALS AND METHODS

3.1 Data Collection and Analysis

This assessment is based on the second-round survey which was carried out from the 9th of September 2018 to the 4th October 2018. The survey training and pretesting was done on the 4th to 7th of September 2018. The survey consisted of 2 teams, each comprising of 1 supervisor and 4 enumerators. The household questionnaire was then administered to beneficiaries (participants) and non-beneficiaries of the ZADT Fund who had participated in the 2017 survey. Those who were absent were replaced with other beneficiaries who were in the program. The survey questionnaire captured information on household demographics and agricultural production, household income, participation in ZADT facility, credit access from other sources, food and nutritional security of the farmers and lastly accessibility from one place to another. Tablets were used to collect the information using the Open Data Kit (ODK) application.

3.2 Sentinel sites

The research was carried out in 8 districts which are Binga, Buhera, Chiredzi, Chipinge, Gokwe North, Mutasa, Mt Darwin and Murehwa. A sample of randomly selected value chains by ZADT was used. Each district was associated with one borrower which supported a specific value chain. In the selection process, both active and mature facilities were chosen. Mature facilities were included in order to evaluate sustainability of the intervention beyond project life.

3.3 Sampling frame

The survey sampled and interviewed farmers who were beneficiaries and non-beneficiaries of the ZADT Fund. Those who have a relationship with the borrower in this case the beneficiaries are referred to as treatment and the non-beneficiaries are referred to as the control. Ward and cluster selection were done randomly with the help of the borrowers in the first round survey. The second round survey was following up on the farmers who had been interviewed in 2017 except for Gokwe North. The list of farmers which was used was obtained from Borrowers and AGRITEX in the 2017 survey and was the one used in the 2018 survey. As for Gokwe North a new list was used since it was not covered in 2017. Tea, mung bean, sugar cane, Michigan pea beans, sesame and bananas had no control groups because all the farmers were linked to the borrower. Control groups were found in the maize and sorghum value chains. Each household had its own unique respondent code and geocoded to enable easy tracking in subsequent rounds of the study. Below is Table 1, which shows the sample sizes for the treatment and control farmers by district, borrower, value chain, status of the facility and overall sample size.

Table 1. Households interviewed in each district with respective value chains in 2017/18 season

District	Borrower	Value chain	Status	Treatment	Control	Total
Binga	Ingwebu Breweries	Sorghum	Active	50	14	64
Chiredzi	Hippo Valley Ltd	Sugarcane	Active	67		67
Murehwa	Intwasa Pfumvudza	Maize	Active	50	13	63
Mt Darwin	Green Trade	Mung beans	Matured	63		63
Buhera	Cairns Foods	Michigan pea	Active	63		63
Mutasa	Hippocrene	Tea	Active	63		63
Chipinge	Matanuska	Banana	Matured	64		64
Gokwe North	Sidella	Sesame	Inactive	59		59
Total						506

3.4 Analytical methods

SPSS and STATA were used to analyze the data. Descriptive statistics and inferences were used for descriptive analysis. Pseudo-fixed-effect and Ordinary least squares regression models were used to estimate the impact of the ZADT Fund on agricultural income, household nutrition, production and productivity. Explanatory variables include individual variables such as age, credit access, and volume of credit, gender, education, access to information, fertilizer application and women empowerment.

Credit access - Two dummy variables were used to measure credit access. One of the variables was a question which asked whether the household had accessed credit in the past 12 months. The second variable asked whether the household had accessed any credit from the borrower, that's if they had a relationship with the borrower. These two variables were both coded 0(no) and 1 (yes).

Volume (intensity) of credit - Most farmers were given loans in the form of inputs hence this variable is the equivalent value of the inputs in monetary terms. In the survey tool the volume of credit is captured as the credit first received when the farmer first borrowed from the borrower and the amount borrowed in the last 12 months.

Duration of the relationship - The survey tool captures the duration of the relationship as the number of years the farmer has had a relationship with the borrower.

Data transformation - to transform the data we used the Inverse Hyperbolic Sine transformation (IHS). The IHS transformation is unique because it is applicable in regressions where the variable to be transformed may be positive, zero, or negative (Friedline et al., 2015; Zhang et al., 2000). We apply the IHS transformation to credit volumes, harvest, yields, crop and farm income as some of the observations of these variable are zero.

4 RESULTS AND DISCUSSIONS

4.1 Socio-economic characteristics of farmers

The descriptive statistics differentiated by value chain are shown in Table 2. From the overall sample, 80% of the interviewed households were male-headed and the average age of the household head was 54 years with an overall farming experience of 24 years for all 8 districts. As indicated by the results, approximately 22% of the respondents accessed credit from other sources besides the borrower. Decision making on input purchases and agricultural credit was

predominantly done by females in all the value chains. Across all the districts 65% of the farmers received information from public extension officers. Over 49% of the sampled farmers in the sugarcane, banana and Michigan Pea bean value chains received extension support from the borrowers. Farmers from the eight (8) value chains were on average located 20 km from AGRITEX offices. Suvedi et al. (2017) revealed that access to extension enhances farmer participation in extension activities and affects technology adoption. Access to extension is expected to enable farmers to make informed farm decisions which subsequently enhance crop productivity. The average arable land for sugarcane farmers was 18 hectares while for sorghum (Binga) and Sesame (Gokwe North) had about 6 hectares and 5 hectares respectively. The other districts tend to have smaller arable land, and this is attributed to population pressure. On average, mobile money agencies were located 28 km from the homestead across all value chains. Mobile money needs to be promoted as it is driving financial inclusion in developing countries (Okello Candiya Bongomin et al., 2018).

About 20% of farmers had enough food to meet their family requirements and food aid was received by about 30% of the farmers. Survey results show that for all 8 districts, food consumption score ranged from between 50 to 85 and average household dietary diversity was 7. These results, show that ZADT supported farmers are associated with higher dietary quality. Radios were owned by 65% of the farmers and this helps farmers in accessing crucial information like weather and climate related information. A total of 96% owned cell phones highlighting high mobile phone penetration rates in rural areas. However, only 24% had access to ICT, which then shows that there is need for extension training to farmers on how they can acquire information through their mobile phones.

The maize and sorghum value chains had counterfactuals. The comparison between the treatment and control farmers shows no significant differences in terms of maize production, yield, dietary diversity and food consumption. The comparison between the treatment and control sorghum farmers showed no significant differences in terms of sorghum production, yield and food consumption. Treated sorghum farmers had higher dietary diversity compared to control farmers. However, these results must be treated with caution given the relatively small sample for the control group (less than 20). Future studies may need to increase the sample size for control groups to enable meaningful comparisons.

Table 2. Socio economic characteristics of farmers and crops grown

Characteristic	Overall sample	Survey area							
		Binga	Buhera	Chiredzi	Gokwe North	Chipinge	Mutasa	Mt Darwin	Murehwa
Social factors									
Head gender (1=male)	0.80	0.83	0.81	0.82	0.83	0.75	0.78	0.84	0.73
Head age	54.16	49.19	54.76	57.52	49.05	55.03	58.11	51.22	57.89
Head marital status (1=married)	0.79	0.84	0.81	0.79	0.85	0.70	0.81	0.81	0.67
Head education (years)	8.25	7.23	8.06	10.52	8.32	8.83	7.10	7.98	7.79
Household size	5.98	6.73	6.03	5.28	7.44	5.59	5.71	6.05	5.11
Sold crops (1=yes)	0.79	0.66	0.97	1.00	1.00	0.89	0.92	0.70	0.22
Decide on input purchase (1=female)	0.79	0.77	0.91	0.67	0.81	0.84	0.76	0.75	0.84
Decide on farm credit (1=female)	0.76	0.73	0.79	0.66	0.80	0.80	0.75	0.71	0.81
Public extension (1=yes)	0.65	0.61	0.95	0.55	0.54	0.78	0.65	0.52	0.57
Borrower extension (1=yes)	0.31	0.22	0.57	0.49	0.00	0.53	0.30	0.17	0.19
Demonstration trial (1=yes)	0.44	0.33	0.62	0.63	0.19	0.48	0.29	0.49	0.51
Field day (1=yes)	0.68	0.88	0.92	0.75	0.37	0.61	0.75	0.62	0.49
Farmer group membership (1=yes)	0.59	0.78	0.52	0.84	0.59	0.41	0.67	0.30	0.59
Farming experience	24.12	19.52	25.38	18.96	23.66	27.28	27.22	23.62	27.68
Institutional factors									
Access to other credit (1= yes)	0.22	0.27	0.17	0.09	0.19	0.21	0.46	0.33	0.02
Access to ICT (1=yes)	0.24	0.31	0.38	0.16	0.19	0.36	0.16	0.21	0.16
Distance to AGRITEX (km)	20.40	18.19	12.13	29.19	16.51	2.36	23.67	28.94	30.93
Distance to mobile money (km)	27.77	17.89	10.21	60.30	6.89	53.20	20.83	24.02	25.19
Land endowments									
Arable area (ha)	5.05	5.87	2.41	17.86	4.85	.49	3.12	3.30	1.74
Food security status									
Self-sufficiency (1= yes)	0.21	0.30	0.35	0.06	0.24	0.30	0.16	0.14	0.11
Received food aid (1=yes)	0.39	0.50	0.59	0.01	0.42	0.23	0.32	0.49	0.54
Household dietary diversity (Max=9)	7.21	6.44	6.57	8.48	6.22	7.34	7.95	7.21	7.35
Food consumption score (Max=126)	59.30	55.51	49.80	84.8	50.28	55.77	61.85	55.93	58.39
Livestock and asset ownership (1=yes)									
Cattle	0.54	0.95	0.54	0.52	0.76	0.38	0.05	0.64	0.52
Goats	0.63	0.83	0.89	0.39	0.80	0.55	0.57	0.52	0.52
Radio	0.65	0.81	0.59	0.79	0.49	0.55	0.71	0.71	0.56
Mobile phone	0.96	0.97	0.95	1.0	0.98	0.97	0.94	0.92	0.95
Wheelbarrow	0.53	0.53	0.59	0.69	0.27	0.53	0.73	0.30	0.56
Number of observations	506	64	63	67	59	64	63	63	63

4.2 Smallholder farmers' access to credit and relationship with the borrower

4.2.1 Nature of operation and challenges faced by smallholder farmers

Hippocrene (Tea value chain)

In Mutasa district, Honde Valley tea farmers were given loans by Hippocrene only once in 2014. The loans were in the form of inputs like fertilizers and some were given pipes for irrigating their tea farms. Cost for the fertilizers was around $43 per bag which was relatively high comparing with the fertilizers from the agro-dealers. Ever since 2014 the tea farmers have not received any loans from Hippocrene and the funding has not been revolving. Currently tea farmers in Honde Valley work with Eastern Highlands Tea Plantations. The company provided loans for the farmers and it is now the only existing buyer of tea in Mutasa after the liquidation of ARDA owned Katiyo Tea Estates. The price for tea still remains at $0.16 per kg and an extra $0.03 for transportation which is depressingly very low taking into consideration that tea production requires a lot of labour and the harvesting process is also very tiresome and time consuming. The stated price is undeniably low and isn't enough to support household needs. Members of the Tea Growers Farmer Association in Honde Valley stated that most of the farmers who had taken the loans in 2014 had already paid off their debt to Hippocrene and very few were left owing. Overall, tea farmers in Mutasa are disgruntled by the way Hippocrene had been operating and are demoralized by the price vis-a-viz the labour that they incurred in tea production. Their hard work produces very little which isn't enough for livelihood.

Cairns Foods (Michigan Pea beans value chain)

The Michigan pea beans project was started by Cairns Foods in Buhera in 2016. Cairns Foods provided the farmers operating in Bonde Irrigation Scheme with the seed and it would also buy their produce. The agreement between the farmers and Cairns Foods stated that all the farmers who had been given seed by Cairns Foods were supposed to sell all their produce to Cairns Foods at the agreed price of $1.20 per kg. Their agreement also stated that none of the inputs they were given were supposed to be diverted to other crops. All farmers who participated in this project were supposed to plant not more than 0.6 ha and not less than 0.2 ha of land to Michigan pea beans. Lion Finance is a financial institution that is working with Cairns Foods to support Michigan pea beans farmers for the past two seasons. Lion Finance provides the farmers with loans to buy fertilizers, chemicals and electricity. Each farmer owning land from 0.2 ha to 0.3 ha received $153 to pay electricity bills and $145.75 to buy inputs. Lion Finance would pay ZESA and the agro-dealers for the chemicals and fertilizers. Each farmer would then receive 100kgs compound D and 50kgs AN. Cairns Foods will pay farmers after deducting the input costs incurred by both Cairns Foods and Lion Finance. Some of the challenges being faced by the farmers are late payments and

late disbursement of inputs by Cairns Food and Lions Finance. The other challenge is that farmers are failing to pay water bills resulting in Zinwa closing water for farmers who didn't pay which then affects their Michigan pea bean production. Cairns Foods and Lion Finance are also facing some challenges in this project. Some of the farmers mix the poor grade and good grade when they send their produce to the Cairns warehouse and there are some who harvest late which is a set back to the company. As for Lion Finance, farmers are failing to pay back their loans.

Green Trade (Mung beans value chain)

Green Trade started contracting farmers in Mt Darwin in 2015/16 to produce mung beans. Green Trade provided loans and bought the mung beans from farmers. The loan was in the form of inputs, the inputs being fertilizer, seed, herbicides and pesticides. Seed was $11 and fertilizer, herbicides and pesticides were $94. In total the package amounted to $105. The loan had an interest rate of 5% per annum. Farmers stated that in order for them to acquire the loan they required the farmers to have land. Contracts were written between the two parties and they stated that their livestock would be used as collateral if they were not able to pay. The buying price agreed upon was $0.69 per kg. In 2016/17 season, farmers who had received the loans, got the inputs late at the end of the rainy season. The few farmers who were able to get something from their harvest were told to grade their harvest and those who had grade A were the ones who would have their harvest bought. The grading process was labour intensive and left most farmers disheartened hence just a few farmers were able to grade and sell. Poor grades were rejected and the farmers had nowhere to sell hence some of the farmers opted to eat their harvest. Due to the delay of the inputs some of the farmers actually failed to plant the crop fearing that they won't be able to harvest anything as the rain season was approaching an end by the time they received the inputs. This has then affected most of the farmer`s loan repayments, most of the farmers have failed to pay their debt to Green Trade and with the interest rate which is imposed by the loan the debt continuously increases. Most farmers complain with the way Green Trade has been operating and the empty promises it made hence most farmers have been disheartened with the mung bean project. Farmers suggested that it would be better if the Contractor could buy the poor grades at low prices or introduce another project for sugar beans because it performs much better than mung bean with their type of soil. In 2017/18 season, the majority of farmers growing mung beans did not receive any support from Green Trade and had no guaranteed off-taker. They will rely on spot markets.

Intwasa /Pfumvudza (Maize value chain)

The Intwasa Pfumvudza program supports the maize value chain in Murehwa. The main goal of this program is to enable smallholder farmers to produce enough food for themselves and also have surplus to sell. In order to achieve this Intwasa Pfumvudza gave farmers in Murehwa loans in 2016. The loans they were given were in the form of inputs which were worth $200. The package of inputs consisted of fertilizers both top and basal and maize seed which were enough for 2.5 ha of land. The interest rate for the loans was 6% annually for every farmer who wasn't able to pay the debt by the cut of date. For those that paid within the cut-off date there was no interest incurred. This mechanism is crucial as it reduces costs incurred by farmers and there is scope to pilot it in other value chain financing schemes. Intwasa/ Pfumvudza is promoting fertilizer micro-dosing. Microdosing is basically the application of small affordable amounts of fertilizer with the seed at planting time or as top dressing 3 to 4 weeks after emergence (Adams et al., 2016). All farmers in the program were encouraged to adapt this technique in the 2016/17 season. All farmers who were in the program were also encouraged to be in groups of ten and to open bank accounts at CBZ. Some of the farmers did not get their inputs because there were challenges in transportation for the extension worker hence some areas were inaccessible.

GMB was the buyer of their maize produce. The buying price was $390 per tonne. To the farmers who were not able to pay for their loans, 12 bags of maize were recovered and each going for $17. To those who had paid something but still owed the amount was deducted from the amount they earned from GMB. In the 2016/17 season, there was late disbursement of inputs hence some of the farmers planted late and some kept the inputs for the next planting season (2017/18). Due to the late disbursement of inputs most of the famers did not harvest up to their expectations. Most farmers who planted in the 2017/18 season had surplus to sell to GMB. They were paid in groups of ten and were encouraged to deliver 1 tonne per member to GMB. The only problem that arose was that the money they were paid was difficult to access due to delays at the bank hence a lot of time was taken following difficult procedures at the bank which was demotivating.

Ingwebu Breweries (Red sorghum value chain)

Red sorghum is the main cash crop in Lusulu, Binga and it is grown by both contracted and non-contracted farmers. The agreement was for Ingwebu Breweries to provide sorghum seed to the farmers and buy the produce. The farmers were given seed only. Each member of the group

received 10 kg seed of red sorghum (Variety NS5511) covering an area of 2 hectares, but other farmers received more. Farmers in Binga are not given loans for fertilizers. One of the reasons is that most farmers don't use fertilizer for their sorghum. In addition, discussions with representatives of Ingwebu revealed that the company wanted to minimize the risk of exposure to the farmers given that they are in dry areas. There is need for research and extension services to pilot and promote fertilizer microdosing in dry areas to boost productivity. The value of 10 kg seed was given to each farmer at $40 and the farmers repaid $45 after interest. Non-contracted farmers mostly use retained seed from their previous harvest. Ingwebu has been successful in enhancing availability of improved seeds to farmers, given that there is severe shortage of red sorghum seeds in agro-dealer shops. This can be attributed to the ZADT success. Farmers were organized into groups and each group was expected to produce at least 30 tonnes. Farmers who work with Ingwebu Breweries mentioned that they don't get extension services from the company and rely on public extension officers. However, farmers feel that regular extension backstopping from Ingwebu is crucial so that they are abreast with the quality requirements needed. Red sorghum market is readily available locally. Ingwebu Breweries comes to the community to collect the produce from its own contracted farmers buying at $310 per tonne. Non-contracted farmers sell their Red Sorghum to GMB located in the area at $390 per tonne. Some contracted farmers do side marketing selling some of the produce to GMB so that they get more money. Farmers complain about the borrower's price which is very low as compared to GMB prices and are requesting for increases in the prices. Last year Ingwebu Breweries failed to make payments to its farmers in time but in 2017/18 season contracted farmers were happy for early payment received. They received their payment soon after delivering their produce via Ecocash.

Matanuska (Banana value chain)

Farmers in Chipinge were contracted by Matanuska which provided working capital for the purchase of inputs in the production of bananas every year. Each farmer gets USD$510 per 6 months from Matanuska and this is deposited into their CABS accounts. The money is used to purchase inputs (fertilizers, sleeves, bailing twine) and payment of electricity bills. They repay the loan at 9% interest rate per annum. Matanuska provides labour for the farmers and deducts their labour cost from the farmers' produce. This is called direct labour. Sleeves and bailing twines are also provided at a cost of 20c and 22c each respectively.

Matanuska buys the produce from farmers, harvest the crop, grades, buys inputs and manage the plots on behalf of the farmer. If the farmer fails to provide labour on the plots, Matanuska provides labour and deduct the cost from farmers' income. Farmers manage their plots under the guidance of Matanuska. Few farmers are failing to provide labour on their plots. These results show the need for extensive farmer training on business management, attitude and relations building and entrepreneurship so that they appreciate all the monetary and non-monetary benefits of their relationship with Matanuska. The majority of farmers expressed satisfaction with the relationship with Matanuska given that income from Banana production accounts for over two thirds of their annual incomes. In addition, Matanuska and the public extension officers are capacity building them as well as Matanuska collects the farm produce from the scheme and farmers have no burden of sourcing for transport. Banana farmers reported that they are facing a number of challenges associated with price fluctuations, water shortages, load shedding and high tax charges given that they pay 15% VAT. Farmers cited challenges associated with delayed financial statements from their bank - CABS. The is need for financial institutions to link farmers bank accounts to their mobile phones so that farmers can track their financial statements timely and in a transparent manner.

Sidella Trading (Sesame value chain)

In the 2017/18 survey there was a change in the district which was surveyed in 2016/17 under the sesame value chain. Instead of Chiredzi, Gokwe North was the one chosen. In this district, Sidella Trading did not provide any loans to the farmers but was an active buyer of their sesame produce. Farmers buy seed from Sidella Trading with a kilogram going for $3. Most farmers planted sesame in 2016/17 season and they bought 3kg of seed which is enough for 1 hectare. Sidella Trading bought the produce at $0.60 per kg. In 2017/18 planting season most farmers did not plant sesame due to lack of funds to buy the seed and unpredictable weather patterns. Sidella Trading should provide loans for Gokwe North farmers so that they are able to continuously produce sesame and benefit from it.

Hippo Valley (Sugarcane value chain)

In the Sugar cane site, both the farmers and the borrower signed a contract called Cane Purchasing agreement (CP). Before being given loans, the banks assessed farmers' fields (plots) to determine if they are capable of producing high yield. Farmers were given the choice to choose the bank they

want to borrow from and currently CABS, CBZ and BancABC are offering loans to farmers. The CP agreement stated that sugarcane farmers were supposed to sell their sugarcane to Hippo Valley. Hippo Valley sold inputs required in sugarcane production on both cash and credit. Inputs sold to farmers included fertilizers; murate of potash (MOP), urea and mono-ammonium phosphate (MAP), herbicides and pesticides. Hippo Valley provided extension services to farmers on land preparation, planting, harvesting, application of fertilizer and chemicals. Hippo Valley provided agronomy extension support and it was very crucial in farm decision making, enhanced production and productivity.

The amounts of fertilizers needed per hectare were; MAP (87 kg for ratoon crop and 100kg for new seedlings), MOP (100kgs) and Urea (350kgs). Farmers also applied Sango (metrabizine), Anaconda (Ametrine), Harness and prowl at a rate of 2 litres per hectares. 10 tonnes (2 bundles) 12 of raw cane is used to plant one hectare. One bundle of raw cane which weighs approximately 5 tonnes cost $350. Land preparation costs remained at last year's level of $600 per hectare which is expensive according to farmers' perceptions. Price of raw sugar in 2017 was $571.61 per tonne, in 2018 the price of raw sugar was $467 in May, and in September the price was $626 per tonne. Challenges faced by farmers included, high cost of production, price fluctuations caused by changing international market forces, late disbursement of inputs and poor road networks and drainage systems.

4.2.2 Collateral required to obtain the credit?

Table 3 indicates that about 75% of the farmers across all the funded value chain actors required collateral to obtain credit. More than three quarters of the farmers who borrowed from Intwasa / Pfumvudza, Green Trade and Hippocrene indicated that collateral was required to obtain the credit. Sidella Trading is just an active buyer and did not offer credit to the farmers in Gokwe North. Generally, the type of collateral which the funded borrowers require usually influences the uptake of the credit by farmers. Failure to have collateral has been identified as one of the major factors hindering smallholder farmers from accessing credit.

The main forms of collateral used were, land (62.2%) and group membership (12.8%). Livestock ownership was another form of collateral used by a total of (8.7%). Land ownership and or access is the major form of collateral being used for Matanuska (100%). Although most of the farmers working with Green Trade chose land as their major form of collateral (44.4%), they also made

use of all the other forms that were available to them. Other forms of collateral such as farm equipment, vehicles and having bank account were less prominent. Though in strict terms, collateral usually has a monetary value, requirements such as group membership does not have a monetary value but possesses administrative value. It becomes easier to work with coordinated group members than dealing with individual farmers. Over 84% of farmers working with Ingwebu Breweries used group membership. If the group is homogenous (having members with similar incentives), farmers can monitor one another thereby reducing the transaction costs. However, the strength of this approach depends on how heterogeneity within groups is managed so as to reduce conflicts. Putting conditions such as group membership may prove to be more accommodative and may be convenient for smallholder farmers who usually lack collateral.

Table 3. Collateral required to obtain credit by type of collateral and value chain (%)

Borrower	N	Percentage indicating that collateral is required	Conditions required to obtain the credit						
			Land	Group membership	Animal	Farm equipment	Vehicle	Bank account	Others (house)
Ingwebu Breweries	48	54.2	-	84.6	-	-	-	-	3.8
Intwasa Pfumvudza	49	91.8	11.1	24.4	31.1	11.1	-	4.4	17.8
Sidella Trading									
Green Trade	61	59.0	44.4	16.7	8.3	2.8	2.8	5.6	5.6
Cairns Foods	63	69.8	63.6	-	22.7	-	-	-	4.5
Hippocrene	61	75.4	93.5	-	-	-	-	-	6.5
Matanuska	64	93.8	100	-	-	-	-	-	-
Hippo Valley	67	82.1	76.4	1.8	-	-	1.8	9.1	3.6
Overall	415	75.2	62.2	12.8	8.7	1.9	0.6	2.9	5.8

4.2.3 Percentage of farmers who borrowed disaggregated by gender

Figure 1 below shows female participation in the credit facility programs from different value chains in the past two years. The results indicate that females were marginally more dominant in 2016/17 than in 2017/18 as compared to male counterparts. This could be a sampling issue given that we had to replace some farmers. About 44% of the smallholder farmers that accessed the ZADT facility were female in 2017/18 as compared to about 51.6% in 2016/17 season. Females were less dominant in mung bean production (Green Trade, 33.3%), Michigan pea beans (Cairns Foods, 39.7%), tea production (Hippocrene, 28.8%) and in sugarcane production (Hippo Valley, 33.3%), indicating that women are not yet actively involved in these value chains. In some areas such as Hippo Valley, female participation is slightly increasing. In 2016/17, women dominated the sesame value chain (80.6%) in Chiredzi. Sidella Trading did not offer credit to farmers in

Gokwe North farmers in 2017/18 season. Overall, results show that the ZADT is financing women. This is in line with the Sustainable Development Goal (SDG5) of promoting gender equality and women empowerment (Pradhan et al., 2017).

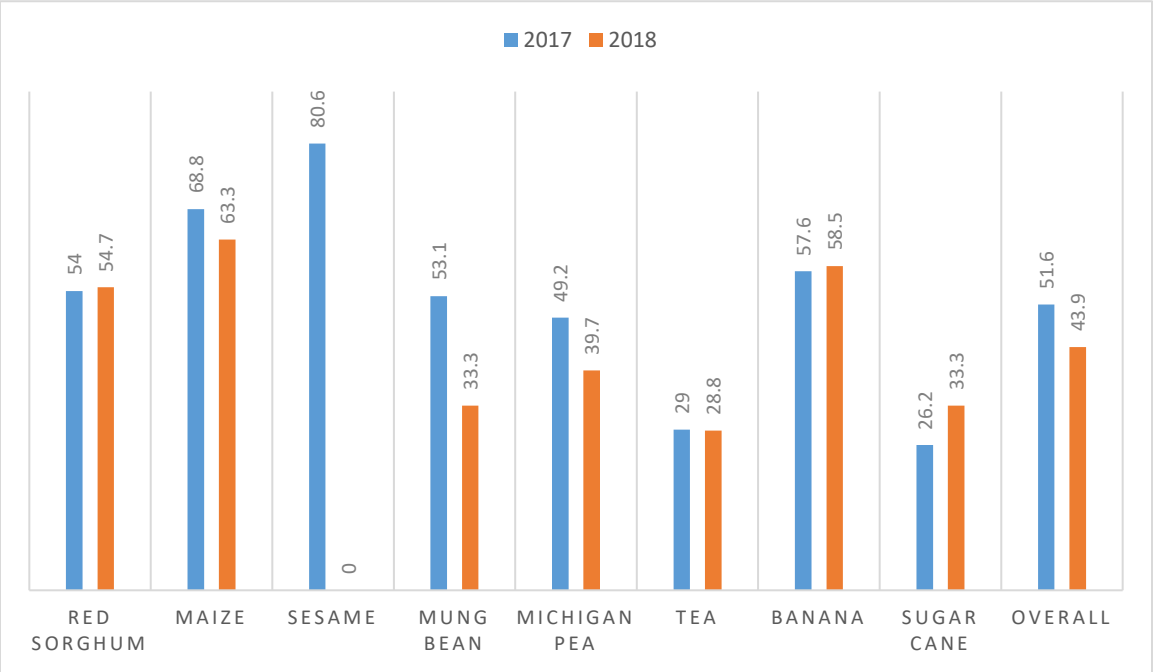

Figure 1. Percentage of female farmers accessing credit by borrower (%)

4.2.4 Form of credit accessed by smallholder farmers.

As illustrated in Table 4 below farmers had access to different forms of credit. The majority of the farmers received credit in kind i.e. in the form of agricultural inputs (72.1%). All of the farmers who borrowed from Ingwebu Breweries and Intwasa Pfumvudza, stated that they were given inputs in form of agricultural inputs. Overall, approximately 20.4% of all the farmers in the sample received cash. Farmers from Cairns Food reported that they accessed the credit in cash (22.2%) and in kind (74.6%). Matanuska and Hippo Valley provided part of the credit in cash with 49.2% and 55.6% of the farmers reported having received the credit in cash respectively. Credit received in kind (processing) had the least occurrences and this was confined to Cairns Foods.

Table 4. Form of credit accessed by smallholder farmers (%)

Form of credit	Overall	Ingwebu Breweries	Intwasa Pfumvudza	Green Trade	Cairns Foods	Hippocrene	Matanuska	Hippo Valley
In kind (Inputs)	72.1	92.5	100	100	74.6	100	26.2	25.4
Cash	20.4	5.7	-	-	22.2	-	49.2	55.6
In kind (Process)	0.5	-	-	-	3.2	-	-	-
In kind (labour)	7.0	1.9	-	-	-	-	24.6	19.0
Observations	412	53	49	60	63	59	65	63

4.2.5 Type of inputs received/purchased using cash from the borrower

The major inputs received by the interviewed farmers were fertiliser and seed (42.2%). Intwasa had all of its farmers being given fertiliser and seed only (Table 5). Ingwebu Breweries only gave out seed and was the only one which did not give out both fertiliser and seed. Seed was the most common form of credit in sorghum production (100%). Irrigation equipment were the least common input received with Matanuska being the only distributor at less than five percent.

Table 5. Major inputs received or purchased (%)

Type of inputs	Overall	Ingwebu Breweries	Intwasa Pfumvudza	Green Trade	Cairns Foods	Hippo-Crene	Matanuska	Hippo valley
Seed	16.0	100	-	16.7	9.5	-	-	-
Fertilizer	18.0	-	-	-	4.8	100	3.1	14.3
Fertilizer and seed	42.2	-	100	83.3	81.0	-	13.8	23.8
Fertilizer and seedlings	18.2	-	-	-	4.8	-	61.5	50.8
Seedlings	4.1	-	-	-	-	-	15.4	7.9
Fertilizer and equipment	0.5	-	-	-	-	-	1.5	1.6
Land preparation	0.5	-	-	-	-	-	1.5	1.6
Irrigation equipment	0.5	-	-	-	-	-	3.1	-
Number of Observations	412	53	49	60	63	59	65	63

4.2.6 Challenges faced in accessing credit from the borrower

Table 6 shows the perceived challenges faced by contracted farmers in accessing credit. In seven value chains there was late disbursement of inputs and stringent requirements for the loans especially Green Trade (57.4%). Due to late disbursement of inputs most of the farmers planted late after the optimum planting time which resulted in low harvests. Over 75% of the farmers working with Ingwebu Breweries and Matanuska had challenges with unclear repayments and also stringent control. The repayment plans were not clear to the farmers. In Mt Darwin, Green Trade only bought “A” grade produce and the other grades were rejected. This left other farmers that

could not meet the quality criteria without a market to sell their produce. Regardless of failing to meet the quality requirements, the borrower expected those to repay the credit therefore farmers complained that they had wasted their time. In all seven funded value chains farmers cited that the ZADT facility improved farmers' access to credit though they were associated with stringent conditions. Stringent conditions are crucial as they reduce the risk of side marketing as well as they ensure good repayments rates and there is scope to train farmers on credit access, management and repayments.

Table 6. Challenges faced by farmers in accessing credit from the borrower (%)

Challenges	Overall Sample	Ingwebu Breweries	Intwasa Pfumvudza	Sidella Trading	Green Trade	Cairns Foods	Hippo crene	Matanuska	Hippo Valley
Late disbursement	19.8	4.1	51.8	0.0	57.4	30.2	17.5	1.6	4.5
Stringent requirement	1.0	0.0	0.0	0.0	1.6	0.0	4.8	1.6	0.0
Late disbursement and stringent requirements	16.8	16.3	21.4	0.0	9.8	25.4	22.2	20.3	23.9
Unclear repayment and stringent requirements	44.5	77.6	14.3	0.0	31.1	44.4	52.4	76.6	71.6
None	18	2.0	12.5	100	0.0	0.0	3.2	0.0	0.0
Observations	433	49	56	10	61	63	63	64	67

4.2.7 Suggested solutions to the challenges encountered by farmers in accessing credit

Table 7 presents the suggested solutions to the challenges encountered by smallholder farmers in accessing the credit from the borrowers. Timely disbursements of loans after application and reduction in charges (interest, transport) were the major recommendations raised by smallholder farmers across all value chains at (20.4%) and (21.3%) respectively. If borrowers give attention to these suggested solutions, it might lead to enhanced loan uptake and subsequent yield increase. Furthermore, about thirteen percent of the farmers suggested that borrowers must have clear repayment procedure so that they gain trust from farmers. Farmer to borrower relationship can be strengthened by transparency between the two. Suggestion on timely disbursements and relaxed requirements was less prominent (5.9%) implying that the conditions were accommodative. Most of the recommendations emphasised by smallholder farmers lead to improved production, income and livelihood of farmers participating in the programme.

Table 7. Solutions suggested by farmers to the challenges encountered in accessing credit (%)

Recommendations	Overall Sample	Ingwebu Breweries	Intwasa Pfumvudza	Sidella Trading	Green Trade	Cairns Foods	Hippo-Crene	Matanuska	Hippo Valley
Timely disbursements after application	20.4	22.4	55.4	-	54.1	22.2	20.6	1.6	-
Timely disbursements and relax requirements	5.9	-	16.1	-	11.5	6.3	11.1	1.6	3.0
Timely disbursements and clear repayment	6.1	2.0	-	-	-	15.9	3.2	15.6	11.9
Reduce charges (transport, interest)	21.3	46.9	3.6	-	-	33.3	3.2	50.0	41.8
Have clear repayment procedure	12.8	2.0	-	-	11.5	4.8	33.3	23.4	26.9
Relax stringent requirements	1.0	-	-	-	1.6	-	6.3	-	-
None	32.4	26.5	25.0	100	21.3	17.5	22.2	7.8	16.4
Observations	506	49	56	10	61	63	63	64	67

4.2.8 Other services received from borrower

Approximately 42.5% of the interviewed farmers indicated that they received extension support from the Borrower (Table 8). Extension support from the borrower is crucial as it improves on farmer's knowledge as well as helps farmers to know what is expected from them in terms of production and how to attain the best quality from their produce. Most of the farmers did not receive training on budgeting and record keeping in seven sites, representing value chains. Close to 25% of the farmers who worked with Cairns Foods and Matanuska had received training on budgeting. This helps farmers in managing their inputs, capital and income and improve their welfare. Less than 3% of the farmers were taught on farm business management which reveals that most of the farmers do not know how to efficiently allocate resources. Providing advice and training on farm business management and record keeping might help farmers appreciate farming as a business. In addition, this may also help in strengthening relationships between borrowers and farmers, thereby reducing the chances of defaulting. An alternative approach that could be used to avail training to farmers so as to improve their level of financial literacy maybe through encouraging formation of farmer associations which would then be used as a vehicle for providing training. Access to extension and training improves farm decision making, marketing and business management. Worryingly, approximately 38% of the interviewed farmers indicated that they did not receive any of these other services from the borrower.

Table 8. Services received from the borrower (%)

Services received	Overall	Ingwebu Breweries	Intwasa Pfumvudza	Sidella Trading	Green Trade	Cairns Foods	Hippo-crene	Matanuska	Hippo valley
Extension	42.5	20.4	41.1	100	47.5	19.0	30.2	31.3	29.9
Record keeping	1.2	0.0	0.0		1.6	0.0	1.6	3.1	3.0
Marketing (packing and handling	6.9	18.4	18.4		8.2	3.2	19.0	4.7	6.0
Farm business management	0.6	0.0	0.0		0.0	0.0	1.6	0.0	3.0
Budgeting	0.4	0.0	0.0		1.6	0.0	1.6	0.0	0.0
Extension and budgeting	9.7	6.1	0.0		8.2	23.8	9.5	23.4	7.5
None	38.7	55.1	58.9		32.8	54.0	36.5	37.5	50.7
Observations	596	49	56	10	61	63	63	64	67

4.2.9 Other credit sources accessed by smallholder farmers

The proportion of farmers accessing credit from other sources is presented in Figure 2. There were a few farmers who obtained credit from other sources, 24% in 2017 and 22% in 2018. These results suggest that farmers have limited options in obtaining credit hence highlight the importance of the ZADT Fund. The majority of these other credit sources were informal credit sources (relatives, neighbours and saving groups). There is need for strengthening Internal Savings and Lending Groups (ISAL) among smallholder farming communities. ISAL members usually use loans and share-out funds for business investments, school fees, health-related expenses, household consumption of purchasing land or livestock in developing countries (Lønborg & Rasmussen, 2014; Parker et al., 2017).

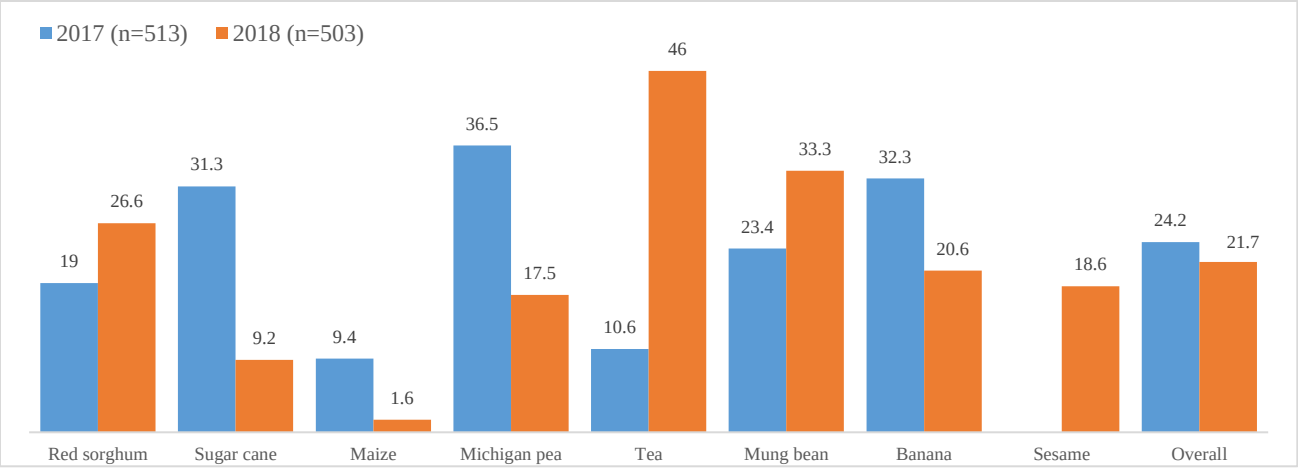

Figure 2. Proportion of farmers accessing credit from other sources by year (%)

4.3 Crop production

4.3.1 Major crops cultivated by farmers in 2017/18 season

Maize, groundnuts, sorghum and sugar beans were the main annual crops grown by the majority of farmers (Table 9). The quantitative survey results show that farmers obtained high yields for

maize, groundnuts, Michigan pea beans and sorghum. These results show that there is need for promoting the production of maize, sorghum, groundnuts and sugar beans which are grown by the majority of farmers. Such interventions could be in form of credit access, linking farmers to local, regional and export markets and value addition. There is huge demand for aflatoxin free groundnuts by processing industries, for example Dairiboard. Agricultural finance mechanisms to support the groundnut value chains are needed in the country. Mung beans, Michigan pea beans and sesame were only confined to the districts where the value chains were being promoted. There is a potential for promoting the production of Michigan Pea beans in other irrigation schemes if markets are guaranteed. Results show that farmers for Michigan pea beans also had high yields. Sesame and mung bean are potentially high-income crops, their production can only proceed if farmers are guaranteed of a market and reasonable prices. These value chains are struggling because of farmers could not meet the quality required and fail to market their crops. In other instances where farmers have produced good quality but the off-taker could not buy all their produce because of liquidity challenges and this ended up demotivating the farmers. This is also evidenced by other impact assessments from the Livelihoods and Food Security Program (LFSP) in Zimbabwe. The main perennial crops that were grown by farmers were tea, bananas and sugarcane which are grown in Mutasa, Chipinge and Chiredzi respectively. These perennial crops were only confined to the value chains that were funded under the ZADT facility except for bananas that were also produced under non-ZADT facility in Mutasa district. This suggests that there is potential for establishing banana value chain in Mutasa under the ZADT facility. There is need to undertake a qualitative lessons learnt assessment of why the two value chains actors previously supported by ZADT did not perform well in Honde Valley.

Table 9. Crops grown by farmers in 2017/18 season (n=506)

Crop	(% of total sample)	Area (hectares)	Yield (kg)/Ha
Annual crops			
Maize	34.7	0.79	1207.61
Groundnuts	16.0	0.27	1130.27
Red sorghum	5.6	1.77	1027.76
White sorghum	2.0	0.74	630.66
Sugar beans	6.6	0.41	953.35
Cowpeas	4.9	0.28	507.84
Sweet beans	1.9	0.45	650.87
Michigan pea beans	4.3	0.28	1116.99
Mung beans	0.5	0.34	625.59
Finger millet	1.4	0.44	450.12
Cotton	6.0	1.36	719.50
Tobacco	1.7	0.94	761.55
Sesame	0.8	0.99	346.5
Pearl millet	2.7	1.26	506.72
Orange maize	0.1	0.60	333.33
Soya beans	0.6	0.50	686.09
Sunflower	1.8	0.58	637.27
Sweet potatoes	0.8	0.34	2040.01
Velvet beans	0.1	0.01	7500.00
Yams	2.4	0.30	1442.32
Yellow maize	0.3	0.91	622.10
Perennial crops (n=306)			
Tea	36.9	0.70	2113.84
Bananas	20.9	0.33	41144.78
Sugarcane	39.5	8.14	8514.95
Coffee	2.6	0.22	187.06

4.3.2 Effect of credit that was accessed by farmers on cereal production and productivity

We estimated the effect of credit access on cereal productivity – maize and sorghum value chains for Binga and Murehwa farmers respectively. We implemented the pseudo-fixed-effect (Mundlak) model (Mundlak, 1978), in which a random effect model is run while simultaneously controlling for unobserved heterogeneity by adding the mean values of plot-varying explanatory variables in an auxiliary regression in order to account for the possible correlation of plot-invariant unobserved heterogeneity with observed covariates. This model is appropriate for our plot-level data given that a household could have 2 or more plots of cereals. The plot level variables that are used in the model include, fertilizer applied (topdressing), production and yield. Household characteristics

included in the model are gender, age, education level as well as access to information. Results from the pseudo-fixed-effect model are shown in Table 10.

Access to ZADT facility through the borrowers had insignificant impact on cereal production. The late disbursement of credit to smallholder farmers had a negative relationship with cereal production for the 2017/18 season. Late credit disbursements reduced cereal yields by 2.8%. The majority of the smallholder farmers in the study area depend on rain fed agriculture and a delay in planting due to late credit inputs results in farmers missing on the planting window. This subsequently reduces productivity. These results demonstrate the importance of timely credit access. The amount of fertilizer applied had a positive influence on both cereal production and productivity. The application of topdressing fertilizer increased both cereal production and productivity by 1.6% and 1.0% respectively. The policy implication is that credit, extension and agricultural programs by both public and private sectors should ensure that farmers have access to fertilizers and trained on appropriate types and use of fertilizers to improve cereal productivity. Vanlauwe et al. (2014) highlights that appropriate use of fertilizer can substantially increase crop productivity in sub-Saharan Africa. This is crucial given the extensive nutrient mining in Zimbabwe.

Table 10. Effect of past year credit on cereal production and productivity

	Harvest		Yield	
	Coef	Std. err.	Coef	Std. err.
Past year credit	-0.183	0.242	-0.001	0.224
Credit late	-1.028**	0.412	-0.565	0.374
Head age	-0.009	0.009	0.001	0.008
Head gender	0.161	0.295	-0.086	0.272
Head education	-0.019	0.034	0.019	0.031
Fertilizer quantity	0.016***	0.003	0.010***	0.003
Decide on credit	-0.358	0.278	-0.084	0.256
Own cattle	0.706**	0.277	0.179	0.256
Extension	0.373	0.256	0.335	0.238
ICT	0.005	0.275	-0.071	0.254
Radio	0.308	0.239	0.533**	0.221
Demonstration	-0.353	0.236	-0.342	0.217
Field day	0.901***	0.276	0.666***	0.255
Mean fertilizer quantity	-0.011*	0.006	-0.002	0.006
Constant	5.770***	0.895	5.821***	0.827
Observations	387		387	
Loglikehood	0.000***		0.000***	

*, **, ***. Statistically significant at the 10%, 5%, and 1% level, respectively.

In Table 11, we report results for the effect of credit access on sorghum and maize yield separately. Access to credit increased sorghum yield by 90.5%. Women empowerment in terms of decision to grow which crops and access to information through field days positively increased sorghum yield. This study reconfirmed that agricultural credit has a positive and highly significant effect on sorghum productivity. The reasons behind the phenomenon may be the significantly higher usage of agricultural inputs like seeds of improved variety and fertilizers which can be transformed into the sorghum yield in the same year. Chandio et al. (2018) report similar findings that credit access improved wheat productivity in Pakistan. In this analysis, only those farmers who obtained agricultural loans from Ingwebu and Intwasa were considered. However, in the rural areas of Zimbabwe, a considerable proportion of small holder farmers take credit from informal financial channels. Therefore, future research should also consider the informal credits as well. Furthermore, these results taken together highlight that interventions that promote credit access among farmers should be complemented by access to information to improve productivity gains.

Table 11. Effect of past year credit on sorghum and maize yield

	Sorghum yield		Maize yield	
	Coef	Std. err.	Coef	Std. err.
Past year credit	0.905**	0.351	0.568	0.424
Head age	0.016	0.017	-0.007	0.016
Head gender	-1.408**	0.611	0.795	1.054
Marital	0.488	0.636	-1.263	0.933
Education	0.029	0.045	0.008	0.075
Sold crop	-0.112	0.348	0.691	0.534
Basal fertilizer quantity	0.002	0.007	0.002	0.005
Topdressing fertilizer quantity	0.009	0.012	0.002	0.005
Decide crop grow	1.791**	0.837	-0.203	1.116
Decide area grow	-0.716	0.737	0.000	0.000
Decide on credit	0.050	0.508	0.363	1.098
Own cattle	-0.968	0.788	0.409	0.429
Extension	0.409	0.363	0.623	0.482
ICT	0.323	0.342	0.111	0.565
Radio	0.257	0.334	0.696	0.453
Demonstration	-0.055	0.329	-0.287	0.461
Field day	1.354***	0.401	0.220	0.502
Constant	4.292**	1.698	5.512***	1.803
Observations	63		95	
Loglikehood	-84.22**		-180.98	

*, **, ***. Statistically significant at the 10%, 5%, and 1% level, respectively.

4.3.3 Effect of credit on Michigan Pea bean production and productivity

Results in Table 12 show the Ordinary Least Squares regression estimates of the amount of credit borrowed last year on Michigan pea production and productivity. Results show the credit amounts

received through borrower had no significant effect on production and productivity of this value chain. Despite access to credit, Michigan Pea bean farmers complained about late disbursement of inputs and intermittent irrigation water cuts by ZESA due to outstanding electricity bills. This greatly affected production and productivity. Late credit disbursements reduced Michigan pea production by 39.2%. The delay in planting due to late credit inputs results in farmers missing on the planting window. This subsequently reduces productivity. These findings demonstrate the importance of timely credit access. Fertilization had a positive and significant effect on Michigan pea production.

Table 12. Effect of credit volume on Michigan pea production and productivity

	Harvest b/se	Yield b/se
Credit volume	0.080	0.096
	(0.202)	(0.321)
Credit late	-0.392**	-0.235
	(0.164)	(0.259)
Head age	-0.013	-0.003
	(0.009)	(0.014)
Head gender	0.224	0.289
	(0.185)	(0.294)
Head education	-0.024	-0.016
	(0.026)	(0.042)
Fertilizer quantity	0.012***	0.008
	(0.003)	(0.004)
Decide on credit	0.545	0.167
	(0.312)	(0.495)
Own cattle	-0.200	-0.290
	(0.149)	(0.237)
ICT	0.206	0.314
	(0.136)	(0.216)
Radio	-0.140	-0.223
	(0.168)	(0.266)
Demonstration	-0.091	0.059
	(0.177)	(0.281)
Field day	0.239	-0.050
	(0.242)	(0.384)
Constant	5.564***	6.814**
	(1.514)	(2.401)
Observations	23	23
Log likelihood	7.546**	-3.066

*, **, ***. Statistically significant at the 10%, 5%, and 1% level, respectively.

There was late disbursement of credit among mung bean farmers in 2016/17 season. Owing to late planting, the majority of the mung beans failed to reach physiological maturity and this affected production. The majority of farmers complained that they wasted their land by engaging in mung

bean production. This resulted in most farmers disadopting the mung bean value chain in 2017/18 season. In addition, there was no support from Green Trade.

4.4 Crop sales and access to market

Contract sales were less common with only Ingwebu Breweries and Hippo Valley using contracts (Table 13). Local trading to neighbours was more convenient for most farmers throughout all the value chains. Approximately 30% of the Sorghum and Sugarcane crop products were traded locally to other neighbours. In the Sesame Value Chain in Gokwe North, the farmers are not selling at the GMB but their local growth points act as their major market. It can also be noted that sesame farmers in Gokwe North, favour their local markets when trading. Over 62% of the produce was sold at the local growth point and the district is the only one that sold its produce using this output market. The only other markets these farmers used was their own local neighbours (10.2%) and the distant informal market (27.1%) which put its total output traded locally at over 70%. Gokwe North is the least active in terms of the number of markets used to trade. Sorghum farmers in Binga traded at almost all the markets available to it except the growth points.

Table 13. Output market for the bulk of crops sold (all crops grown by sampled farmers) %

Output market	Overall	Binga	Chiredzi	Gokwe North	Murehwa	Buhera	Mutasa	Mt Darwin	Chipinge
Contract (borrower)	2.1	1.6	14.3	-	-	-	-	-	-
Local (to neighbours)	21.0	31.1	12.7	10.2	23.0	28.8	19.0	12.1	30.6
G.M.B	10.4	18.8	11.1	-	8.2	11.9	13.8	15.5	3.2
Local market (Growth point)	7.7	-	-	62.7	-	-	-	-	-
Distant informal market	12.9	8.2	-	27.1	39.3	11.9	10.3	6.9	-
Distant formal market	7.3	23.0	6.3	-	3.3	3.4	3.4	15.5	3.2
Other contracts	38.7	16.4	55.6	-	26.2	44.1	53.4	50.0	62.9
Observations	506	64	67	59	63	59	63	63	64

4.5 Distance from the output market

T-statistic tests were used to analyse the significance of the differences between distances travelled by farmers to their markets (to the borrower and other markets) (Table 14). Farmers travelled shorter distances to market to the borrower for sorghum, Michigan peas and tea compared to distance travelled to sell to other markets. Farmers linked to borrowers were associated with shorter travel distances to markets except for farmers in Chiredzi who had to travel longer distances to sell their sugarcane to Hippo Valley Milling plants. For the maize farmers in Murehwa there were no significant differences in distances travelled. These results show that the ZADT program

played a crucial role in reducing output market distances for farmers participating in four value chains. This is important as it reduces transaction costs.

Table 14. Distances travelled to the market and borrower (km)

Value Chain (Site)	Distance to other markets	Distance to the borrower	Difference (km)
Sorghum (Binga)	7.0	2.1	4.9***
Sesame (Gokwe North)	8.1	-	-
Sugarcane (Chiredzi)	43.4	59.9	-16.5***
Maize (Murehwa)	9.5	9.5	0.0
Michigan peas (Buhera)	5.4	2.7	2.7***
Tea (Mutasa)	5.4	1.8	3.6***
Mung bean (Mt Darwin)	37.2	-	-
Banana (Chipinge)	3.2	1.3	1.9*

*, **, ***. Statistically significant at the 10%, 5% and 1% level respectively.

4.6 Level of market participation

Table 15 presents the crop sales differentiated by district. The upper panel consist of crops funded under the ZADT facility. Maize was sold in all districts except Chipinge. Maize sales were noted in Binga, Gokwe North, Mt Darwin and Murehwa. Red sorghum, tea, sugar cane and Michigan pea sales were mostly confined to the specific districts where the value chain was promoted. Credit facilities for banana were mostly confined to Chipinge. There were also banana sales in Mutasa and Chiredzi and there is scope for expanding extensive banana production in Mutasa and Chiredzi.

The lower panel shows crop sales for crops that were not part of the funded value chains. Cotton recorded the highest sales and these were concentrated in Chiredzi and Chipinge. These are traditional cotton growing areas that also have cotton ginneries in the districts. These results suggest that there is potential for financing other crops. Future ZADT programs might consider funding sugar beans and cotton value chains. Encouraging the production of crops that they are used to would be easier for the farmers and would contribute positively to the sustainability and continuity of value chains. The policy implication is that the promotion of crop value chains should be guided by suitability of areas for crop growth. In addition, robust and stringent conditions coupled with farmer training should be promoted to avoid side marketing.

Table 15. Crop sales by district for 2017/18 season (%)

	N	Binga	Chiredzi	Gokwe North	Murehwa	Buhera	Mutasa	Mt Darwin	Chipinge
Value chain crops									
Maize	72	38.9	5.6	18.1	12.5	5.6	4.2	15.3	
Banana	64		1.5				1.5		97.0
Red sorghum	47	100							
Tea	48						100		
Sugar cane	68		100						
Michigan pea	58					100			
Non-value chain crops									
Sugar beans	55	13.1		33.9	24.6	3.4	6.9	10.3	1.6
Pearl millet	4	1.6			3.3			1.7	
Groundnuts	23	6.6		5.1	11.5	5.1	6.9	3.4	
Cotton	81	4.9	30.2	1.7	6.6	16.9	19.0	17.2	37.1
Cowpeas	7	1.6	1.6	1.7		1.7	1.7		3.2
Tobacco	24	4.9	11.1		3.3	13.6	3.4	1.7	1.6
Bambaranuts	4	3.3					1.7	1.7	
Other crops	104	21.3	17.5	30.5	26.2	20.3	15.5	13.8	27.4

4.7 Contribution of ZADT Fund to total crop sales

To understand the welfare impacts of ZADT Fund, there is need to compute its contribution to the total crop income. Revenue obtained from crop sale denotes the value of harvested crop that was actually traded (sold). As shown in Table 16, this is split into two (i) revenue from all crop sales and (ii) revenue obtained through trade that was made under the ZADT facility (borrower). The contribution of the sales from ZADT value chain crops to the total revenue generated from all sales is shown in Table 16. This provides a proxy indicator of the performance of the ZADT Fund towards enhancing market access and revenue generation. The results show that revenue from the banana and sugar cane value chains supported by ZADT facility accounted for over 94% of the total crop revenue in both 2017 and 2018 cropping seasons. In the Sorghum (Binga) and Tea (Mutasa) value chains, the ZADT facility contributed approximately 74% and 61% of the total crop revenue in 2016/17 and 70% and 72% in 2017/18. For the two consecutive seasons, sugar cane, banana, red sorghum and tea consistently and significantly contribute to more than 60% of the total crop revenue. These seem to be the best performing value chains under the ZADT facility and partly this is because of the well-structured marketing of these value chains and availability of irrigation. In the Michigan value chain (Buhera), sales through the ZADT facility contributed 54% and 41% to the total crop revenue in 2016/17 and 2017/18 respectively. In the Mung bean value chain (Mt Darwin), farmers had a challenge in meeting quality requirements and recorded the least percentage contribution of sales under ZADT in 2016/17. The borrower only bought the ‘A’ grade

product from the farmers and this reduced the amount of revenue received under the ZADT facility. In 2018, the few farmers in Mt Darwin produced Mung bean on their own and had no marketing channels. On a positive note, some farmers in Mt Darwin indicated that they are still willing to grow mung bean if there is a guaranteed market and viable producer prices. Sesame producing farmers in Chiredzi sold their produce through other channels. Sidella Trading did not contract farmers in 2016/17 season. Farmers are expected to develop long lasting relationships with the borrowers. In 2017/18, sesame farmers in Gokwe North did not receive any inputs from Sidella Trading. Sidella only bought the sesame produce with no credit support. Farmers requested that Sidella should strive to avail credit to farmers to cushion them against input price risks.

Table 16. Contribution of crop sales under ZADT Fund to total household sales by year

	2017				2018			
Value chain	N	All Sales (US$)	Sales to borrower (US$)	Contribution of ZADT to total sales (%)	N	All Sales (US$)	Sales to borrower (US$)	Contribution of ZADT to total sales (%)
Sugarcane	65	307801	298602	96.7	67	4400676	4397664	100
Banana	65	3820	3712	96.1	66	167056	157288	94
Sorghum	50	971	645	73.5	47	50921	35507	70
Tea	65	2545	844	60.9	48	99925	72075	72
Michigan pea	61	793	338	53.5	58	52956	21791	41
Maize	34	275	131	48.3	-	-	-	-
Mung Bean	55	1350	184	16.4	-	-	-	-
Sesame*	53	440	0	-	-	-	-	-
Total	448			58.3 (76)	286			75

*Sesame farmers were interviewed in Chiredzi in 2017 and Gokwe North in 2018. Maize, mung bean and sesame value chains were dropped in the analysis because the value chain has been dropped by many farmers or lack of clear borrower –farmer relationship in 2018.

4.8 Effect of the ZADT facility on crop income

Table 17 shows the estimated results of the effect of ZADT facility on annual crops income among red sorghum, maize and Michigan pea farmers in Binga, Murehwa and Buhera respectively. Access to ZADT facility in the past 12 months (through borrowers) had no significant association with crop income for all the three value chains. Land size has a positive and significant effect on red sorghum and maize income. An additional hectare in land size increased crop income by 10% and 17% among sorghum and maize farmers respectively. These findings have important policy implications as well. Due to land and labour scarcity in some communal areas of Zimbabwe, land area expansion is not a feasible strategy. Instead, policy makers should focus on promoting the

adoption of sustainable intensification practices and labour saving technologies (rippers, shellers etc) among rural households in Zimbabwe. Sustainable intensification practices that aim to increase output per unit of input resource while conserving the natural resource base include for example modern high-yielding varieties, crop rotation, and soil and water conservation practises (Smith, 2013). Policy intervention to increase crop income should emphasize on promoting credit access in tandem with sustainable intensification practices and mechanization to smallholder farmers. In addition, timely credit disbursements in line with the agricultural season are critical for improved household welfare.

Table 17. Effect of credit access on annual crop income

	Red sorghum		Maize		Michigan pea	
	Coef	Std. err.	Coef	Std. err.	Coef	Std. err.
Past year credit	-0.138	0.261	0.572	0.581	-0.170	0.449
Credit late	0.000	0.00	-0.520	1.444	-0.253	0.269
Head age	0.015	0.009	-0.006	0.023	-0.005	0.013
Head gender	0.387	0.301	-0.642	0.701	0.206	0.335
Head education	0.011	0.027	0.044	0.058	-0.014	0.040
Arable land	0.096***	0.034	0.171**	0.064	0.050	0.109
Decide crop to grow	-0.264	0.366	-0.405	0.779	0.472	0.741
Decide on credit	0.433	0.327	0.358	0.830	-0.019	0.515
Own cattle	0.168	0.442	0.736	1.848	-0.126	0.214
Extension	0.076	0.241	0.500	0.627	0.000	0.000
ICT	0.348	0.237	-0.008	0.515	0.273	0.293
Radio	0.109	0.218	0.438	0.514	-0.043	0.242
Demonstration	0.137	0.205	0.883*	0.498	-0.027	0.267
Field day	-0.212	0.328	-0.065	0.753	0.243	0.466
Constant	5.276***	0.940	3.261	2.733	6.288***	1.293
Observations	47		41		25	
P-value	0.076*		0.070*		0.737	
Log likelihood	-35.011		-55.298		-4.053	

*, **, ***. Statistically significant at the 10%, 5%, and 1% level, respectively.

Table 18 shows the effect of credit obtained in the last 12 months (through borrower) on crop income among tea, banana and sugarcane farmers. Access to credit in the past 12 months had a significant effect on sugar cane income only. Access to credit increase sugar cane income by 95%. Given perennial crops (tea and banana) have longer production period, the public and private sectors should design longer term credit schemes for this category of value chains.

Table 18. Effect of credit access on perennial crops income

	Banana		Sugarcane		Tea	
	Coef	Std. err.	Coef	Std. err.	Coef	Std. err.
Past year credit	-0.219	0.205	0.951*	0.526	0.579	0.425
Credit late	0.121	0.108	0.040	0.757	0.296	0.683
Head age	-0.003	0.004	-0.005	0.008	-0.043*	0.023
Head gender	0.135	0.118	0.534*	0.272	1.010*	0.508
Head education	0.004	0.017	0.019	0.025	-0.072	0.075
Arable land	-0.207***	0.075	0.023	0.017	0.286***	0.101
Decide crop to grow	-0.118	0.191	-0.907*	0.507	-1.723	1.491
Decide on credit	-0.014	0.175	0.828	0.530	0.954	1.424
Own cattle	0.114	0.102	0.119	0.188	0.271	1.469
Extension	-0.115	0.121	-0.195	0.190	0.624	0.446
ICT	0.076	0.110	-0.089	0.279	-0.448	0.639
Radio	-0.086	0.096	0.709***	0.263	-0.791*	0.426
Demonstration	0.030	0.092	-0.014	0.209	0.074	0.602
Field day	0.012	0.095	0.226	0.214	1.886***	0.544
Constant	8.910***	0.380	8.680***	1.162	5.532***	1.808
Observations	66		67		48	
P-value	0.033**		0.002***		0.006***	
Log likelihood	-13.811		-61.367		-69.517	

*, **, ***. Statistically significant at the 10%, 5%, and 1% level, respectively.

Table 19 shows the effect of the volume (intensity) of credit on selected crop income among sampled farmers participating in the red sorghum, maize, banana, Michigan peas and tea value chains. For red sorghum, credit tends to have significantly positive impacts on income for farmers receiving larger credit volumes. These results suggest that larger credit volumes tend to have higher welfare gains among sorghum farmers. These results demonstrate the need to disburse meaningful credit amounts to smallholder farmers if welfare gains are to be achieved (Luan & Bauer, 2016). Given the fact that Ingwebu is currently only providing credit for seed this means if the company extends support to include other inputs such as fertilizers this will have a phenomenal impact on household income.

Table 19. Effect of credit volume on selected crop income

	Red sorghum		Maize		Banana		Michigan pea		Tea	
	Coef	Std. err.	Coef	Std. err.	Coef	Std. err.	Coef	Std. err.	Coef	Std. err.
Credit volume	0.169*	0.084	-0.091	0.367	-0.005	0.040	0.082	0.333	-0.092	0.483
Credit late	0.000	.	0.169	3.079	0.044	0.084	-0.550	0.360	0.256	0.845
Head age	0.023	0.013	-0.072	0.097	-0.001	0.003	-0.019	0.017	-0.069*	0.036
Head gender	0.430	0.311	-1.880	1.726	0.012	0.088	0.052	0.359	1.741	1.264
Head education	-0.014	0.031	0.155	0.158	0.007	0.012	-0.037	0.044	-0.070	0.218
Arable land	0.109**	0.046	0.033	0.218	0.234***	0.087	0.160	0.138	0.240	0.168
Decide crop grow	-0.230	0.556	0.954	2.440	0.099	0.158	-0.450	1.023	-0.908	2.176
Decide on credit	0.084	0.450	0.700	3.042	-0.224	0.143	0.867	0.855	1.281	1.741
Own cattle	0.000	0.000	0.000	0.000	0.103	0.079	-0.212	0.258	1.023	1.979
Extension	-0.108	0.274	0.348	1.371	0.024	0.096	0.000	0.000	0.160	0.825
ICT	0.650**	0.292	-0.418	1.978	-0.013	0.082	0.489	0.337	-0.746	1.055
Radio	0.460	0.355	0.688	1.948	-0.030	0.072	-0.035	0.277	-0.046	0.930
Demonstration	-0.012	0.322	1.368	2.042	0.075	0.068	-0.238	0.324	-0.081	1.312
Field day	0.613	0.704	0.107	2.430	-0.030	0.071	-0.082	0.536	2.811***	0.864
Constant	3.554**	1.149	7.129	5.231	8.404***	0.442	7.043**	2.756	6.029*	2.875
Observations	24		20		62		23		24	
P-value	0.076*		0.761		0.243		0.665		0.195	
Log likelihood	-6.0		-26.5		7.8		-2.6		-28.6	

*, **, ***. Statistically significant at the 10%, 5%, and 1% level, respectively.

Table 20 shows the effect of initial amount of credit borrowed and the duration of relationship with borrower on selected crop income. The coefficient of credit volume were not statistically significant among red sorghum, banana and Michigan pea farmers. The volume of credit had a negative association with sugarcane income realized by farmers and this may be partly explained by late disbursement of inputs and poor road networks which increased transaction costs. The duration of relationship with borrower had a positive and significant association with crop income for sugarcane and Michigan pea farmers. An additional year of borrower-farmer relationship increased income among sugarcane and Michigan pea farmers by 14.5% and 45.2% respectively. These empirical results highlights that interventions that seek to increase crop income should emphasize on nurturing and promotion of long-term relationship between credit providers and farmers to enhance household welfare.

Table 20. Effect of initial credit borrowed and duration on selected crop income

	Red Sorghum		Banana		Sugarcane		Michigan peas	
	Coef	Std. err.	Coef	Std. err.	Coef	Std. err.	Coef	Std. err.
Credit volume (initial amount)	0.060	0.081	0.031	0.123	-0.072*	0.041	0.129	0.283
Duration	0.087	0.073	-0.024	0.059	0.145*	0.081	0.452*	0.247
Head age	0.010	0.011	-0.004	0.004	0.001	0.008	0.000	0.011
Head gender	0.434	0.300	0.129	0.125	0.408	0.270	0.297	0.269
Head education	0.010	0.027	-0.000	0.018	0.027	0.025	0.004	0.037
Arable land	0.093**	0.043	-0.242***	0.070	0.026	0.017	0.026	0.093
Decision crop to grow	-0.335	0.389	-0.133	0.197	-0.904*	0.516	0.944	0.606
Decision on credit	0.452	0.347	-0.053	0.178	0.780	0.538	-0.440	0.382
Own cattle	0.274	0.463	0.144	0.104	0.088	0.192	-0.077	0.204
Extension	0.103	0.232	-0.119	0.128	-0.181	0.192	0.000	0.000
ICT	0.318	0.240	0.119	0.112	-0.042	0.283	0.235	0.243
Radio	0.139	0.236	-0.083	0.100	0.662**	0.261	-0.258	0.218
Demonstration	0.115	0.208	0.034	0.097	-0.070	0.220	-0.052	0.243
Field day	-0.148	0.322	-0.001	0.099	0.194	0.217	0.590	0.388
Constant	4.667***	0.831	8.763***	0.695	10.541***	0.634	3.621*	1.925
Observations	46		65		67		25	
P-value	0.184		0.073*		0.005***		0.498	
Log likelihood	-33.914		-15.398		-62.628		-1.707	

*, **, ***. Statistically significant at the 10%, 5%, and 1% level, respectively.

4.9 Reasons for selling crops

Results from Table 21 shows that most of the income obtained from crop sales was used to pay school fees (25.3%) and other household expenses like clothes, groceries and furniture (27.7%). Ability to sell part of their produce enables farmers to buy other food items which are important for dietary diversity and investment in education has a positive effect on development. Part of the income was reinvested into agricultural activities through purchases of farm inputs and implements. Farming becomes sustainable if farmers are able to reinvest. An overall of eleven percent used their income from crop sales to acquire building material for construction. Use of income to pay for hired labour, buy livestock or cover medical expenses was less prominent. Use of crop income to hire labour was more prominent in Chiredzi for sugar cane producers (15%). This is expected given that sugar cane producers cultivate larger areas and therefore require hired labour. This suggests that job creation can be attained when farmers operate at a larger scale. Increasing scale of production should be encouraged across value chains. Operating on large scale enables farmers to get benefits associated with economies of scale.

Table 21. What were the reasons for selling your produce? (%) multiple responses possible

Reasons for selling	Overall	Ingwebu Breweries	Sidella Trading	Hippo Valley	Intwasa Pfumvudza	Cairns Foods	Hippo-crene	Matanuska	Green Trade
Wanted to buy maize	5.5	3.2	1.5	-	4.3	9.7	0.9	19.5	1.1
Wanted to pay fees	25.3	34.4	23.8	20.5	26.1	27.6	27.4	22.0	23.4
To pay hired labour	4.5	5.4	3.1	15.2	-	1.1	2.7	0.8	3.2
To buy inputs/implements for next season	17.8	8.6	26.2	21.2	17.4	17.8	18.6	7.3	22.3
Buy livestock	4.5	11.8	3.8	4.0	-	6.5	-	4.1	2.1
Medical costs	3.5	1.1	3.8	4.0	13.0	1.6	6.2	1.6	5.3
Other household expenses (clothes, Food and furniture)	27.7	19.4	33.8	13.2	30.4	25.9	41.6	24.4	41.5
Building material/ construction	11.2	16.1	3.8	21.9	8.7	9.7	2.7	20.3	1.1.
Total	912	93	130	151	23	185	113	123	94

4.10 Challenges encountered by smallholder farmers during crop sales

Farmers across all value chains faced a wide range of challenges during the selling of their produce (Table 22). Results show that across all value chains, farmers indicated that the prices of the products were low, suggesting that they did not get the revenue they expected from their crop sales and it's insufficient to sustain them. Delays in receiving payments and expensive transport were the other challenges highlighted by farmers. Delays in payments and complicated payment procedure are demotivating and leave most farmers disgruntled. Some farmers in Murehwa under the maize value chain mentioned that they had to wait for 6 months to receive their payment. Expensive transportation of goods makes it difficult for farmers to sell their produce at distant markets. These exorbitant transport cost reduces profitability. Usually transport costs tend to be high if there is uncoordinated selling. Organised /coordinated selling enables farmers to pull resources so as to capitalise on economies of scale. Farmers also faced challenges of over flooded markets especially in Mutasa (16.9%) this is because most farmers in Honde valley are tea growers and just one buyer hence this problem is bound to arise. Addressing these challenges will go a long way in facilitating loan uptake.

Table 22. Challenges faced by farmers in selling their produce (%) multiple responses possible

Challenges	Overall	Ingwebu Breweries	Sidella Trading	Hippo valley	Intwasa Pfumvudza	Cairns Foods	Hippocrene	Matanuska	Green Trade	Other markets
Low prices	43.1	40.4	29.4	28.6	57.1	38.0	60.2	67.3	31.1	40.6
Delayed payments	13.5	8.5	29.4	1.8	-	15.5	7.2	17.3	10.8	29.0
Expensive transport	13.3	25.5	5.9	58.9	-	1.6	7.2	-	20.3	4.3
Market flooded	7.4	4.3	29.4	-	14.3	9.3	16.9	1.9	5.4	-
No transport to market	4.3	5.4	-	-	-	3.1	4.8	-	12.2	4.3
Failing to meet quality	4.4	2.1	-	1.8	-	11.6	-	7.7	4.1	1.4
No willing buyer	1.8	-	-	-	-	7.0	-	-	1.4	-
Failing to meet quantity	3.5	2.1	-	-	-	10.9	-	3.8	1.4	-
No challenges	8.7	10.6	5.9	8.9	28.6	3.1	3.6	1.9	13.5	20.3
Number of responses	541	47	17	56	14	129	83	52	74	69

4.11 Livestock production

4.11.1 Types of animals owned

Table 23 presents the types of animals currently owned by smallholder farmers across all value chains. The results show that most of the farmers own cattle, goats and chickens each accounting for 54.3%, 62.8% and 78.5% respectively. Livestock is a crucial resource for smallholder farmers. It's a store of value, source of draught power, manure and income. These results demonstrate that ZADT is working with economically active farmers as compared to vulnerable farmers who in most cases require food aid. These three types of livestock are dominant throughout all the sites. Turkeys and guinea fowls also seem to be common throughout all the sites. Sorghum farmers in Binga had the highest number of cattle, goats and chickens at 95.3%, 82.8% and 92.2% respectively. Considering that cattle and goats are normally used as a store of value, it can be said that these people own a sizeable amount of wealth. Binga lies in the sweet veld which is ideal for livestock rearing. Mutasa on the other hand has the least cattle (5%). This might be because Mutasa is not a livestock production region as it lies in the sour veld. Livestock production enhances economic viability and sustainability of a farming system. There is need to pilot agricultural finance schemes that target livestock production in Chiredzi and Binga. For example financing small stock production through breed improvement and beef feeder finance schemes.

Table 23. Types of animals owned by farmers (%) (n=506)

Type of animal	Overall	Binga	Chiredzi (Sugarcane)	Murehwa	Buhera	Mutasa	Mt Darwin	Chipinge	Gokwe North
Cattle	54.3	95.3	52.2	52.4	54.0	4.8	63.5	37.5	76.3
Donkeys	8.3	31.3	3.0	1.6	7.9	1.6	9.5	-	11.9
Pigs	3.2	12.5	3.0	1.6	-	-	-	1.6	6.8
Sheep	4.5	6.3	7.5	-	19.0	-	-	-	3.4
Goats	62	82.8	38.8	52.4	88.9	55.6	52.4	54.7	79.7
Chicken	78.5	92.2	49.3	93.7	87.3	95.2	71.4	50.0	91.5
Ducks	3.4	3.1	6.0	-	3.2	-	-	4.7	10.2
Guinea Fowl	15.0	39.1	6.0	3.2	17.5	1.6	4.8	4.7	45.8
Turkey	8.5	9.4	7.5	11.1	11.1	4.8	4.8	1.6	18.6
Rabbits	1.8	1.6	3.0	4.8	-	1.6	-	1.6	1.7

Table 24 shows the average number of livestock animals that are currently owned by farmers in each survey district. Cattle, goats and sheep are the majority of farm animals owned by farmers. Farmers under the sorghum (Binga) and sugarcane (Chiredzi) own more cattle and chicken than the rest of the value chains. These two districts lie in the sweet veld which is conducive for livestock ranching compared to the other districts which are located in the sour veld. From a policy perspective, interventions for livestock production; for example, livestock finance and feeder scheme should be targeted to these districts. Of course, the major challenge is that Chiredzi and Binga border national parks and animals in these areas are susceptible to foot and mouth diseases. Hence there is need to invest in fencing by the government to demarcate game parks from communal areas of the country. Results also show that farmers in Chiredzi reared lots of rabbits.

Table 24. How many livestock do you currently own?

Livestock owned	Overall	Binga	Gokwe North	Chiredzi	Murehwa	Buhera	Mutasa	Mt Darwin	Chipinge
Cattle	7.75	11.03	5.51	17.51	4.39	5.06	5.0	3.30	4.54
Donkeys	3.40	4.55	1.86	2.0	0.0	3.20	1.0	0.0	0
Pigs	3.75	3.12	5.25	3.5	5.0	0	0.0	0	2.0
Sheep	9.74	8.50	8.50	12.60	0	9.17	0	0	0
Goats	8.68	11.40	8.49	21.38	3.27	10.36	3.80	4.36	6.77
Chicken	14.89	21.39	11.94	24.70	11.37	13.84	14.98	10.96	11.41
Ducks	5.47	3.0	5.33	7.25	0.0	2.0	0	0	7.33
Guinea fowls	8.33	10.08	7.22	7.00	8.0	7.3	6.0	11.00	7.33
Turkeys	5.93	11.50	5.45	7.00	3.14	5.43	2.67	7.0	2.0
Rabbits	17.56	5.00	11.0	55.0	5.67	0	8.00	0	7.0

4.11.2 Output market of the livestock and livestock products

Farmers provided information on their livestock output market. Table 25 presents the output markets differentiated by the type of livestock. The major output market for livestock is local markets (neighbours) (45%). This means that most farmers sell to each other in their communities. Twenty percent of the farmers mentioned that they had sold their pigs to distant informal markets and 28% of the farmers said they had sold their cattle to distant formal markets. These results reveal a lack of market for livestock locally hence presents an opportunity for developing interventions in livestock value chains. Some of the livestock animals are reared to meet household needs and are not usually sold like rabbits and ducks.

Table 25. Where did you sell your livestock? (%)

Output market	Cattle	Pigs	Sheep	Goats	Chicken	Ducks	Guinea fowls	Turkey	Rabbit
Local (neighbours)	45.0	40.0	33.3	75.0	89.9	100	83.3	75.0	100
Distant(informal)	8.3	20.0	33.3	8.3	1.4		-		
Distant formal market	28.3	-	16.7	2.8	1.4	-	-		-
Local (Growth point)	15.0	20.0	16.7	9.7	7.2	-	16.7	25.0	-
Other	3.3	20	-	4.2	-		-		
Observations	60	5	6	72	69	1	12	8	2

Figure 3 below shows the proportions of the whole sample who produced different livestock products across all the districts in 2017 and 2018. Eggs and chicken were recorded as the most

produced products with over forty percent respectively in 2017 and in 2018 this dropped to below 25% respectively. This can be attributed to the avian flu outbreak that was widespread in the country resulting in low productivity among the major egg and chick hatcheries in the country. Cow milk was the third most common livestock product that was produced and sold in the two seasons. Livestock interventions should promote the breeding and production of broilers and layers including indigenous chicken breeds, for example Boshveld. Disease surveillance and control mechanisms should be reinforced to improve livestock health. Where appropriate access to rural finance to support these livestock value chains should be encouraged as they provide farmers with quick returns when sold.

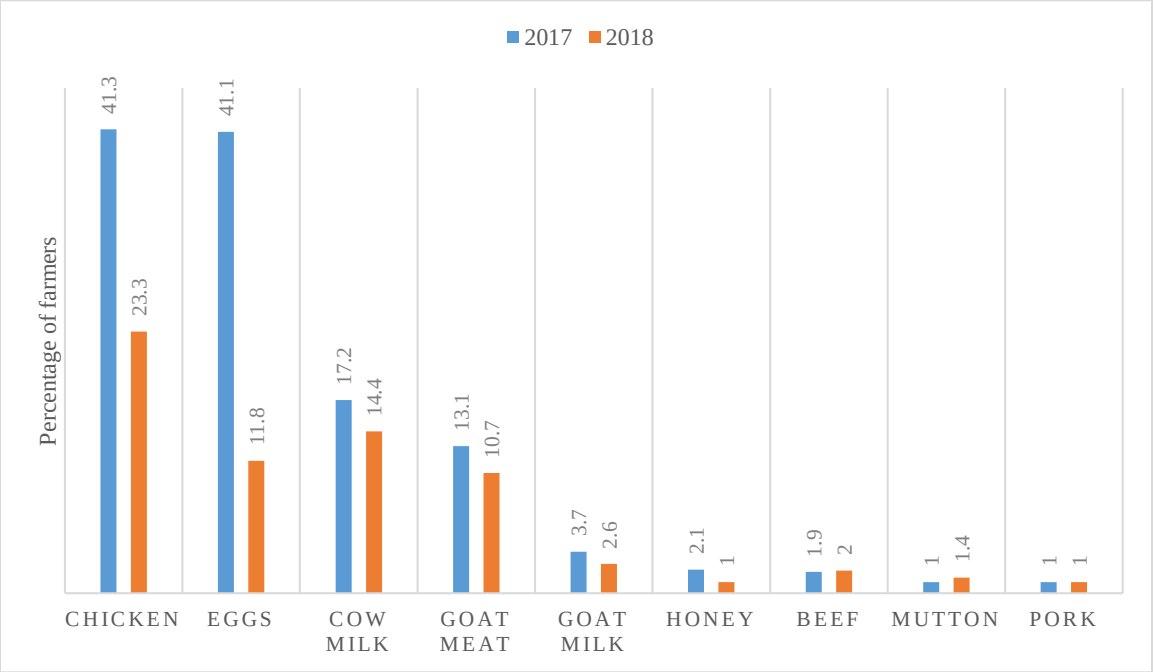

Figure 3. Livestock products produced (%) in 2017 (n=513) and 2018 (n=506)

4.12 Off-farm income and other livelihoods strategies

In addition to agricultural income, household have other off farm income sources. Across all the sites, remittances, business and labour sales were the dominant income and livelihood strategies accounting for 24.7%, 16.4% and 12.3% respectively (Table 26). This shows that most farmers are dependent on money or groceries that are sent by either their children or relatives. Most of the farmers who acquired income from their pension money were from Chiredzi (33%). Close to 10% of all farmers in all the districts have paying jobs that they depend on. This can be an indication of

the persisting economic hardship and lack of employment. Generally these results demonstrate low off-farm income diversification among smallholder farmers. Strategies that increase income diversification are required in the smallholder farming communities. A growing number of studies demonstrate the positive impact of off-farm income on household food security, nutrition and income smoothing (Babatunde & Qaim, 2010; Owusu et al., 2011).

Table 26. Off-farm income sources in the past 12 months, % (n=506).

Type of off farm income	Overall	Binga	Chiredzi	Gokwe North	Murehwa	Buhera	Mutasa	Mt Darwin	Chipinge
Remittances	24.7	14.1	19.4	16.9	39.7	22.2	34.9	25.4	25.0
Business	16.4	20.3	19.4	16.9	4.8	19.0	17.5	14.3	18.8
Labour sales	12.3	9.4	3.0	10.2	17.5	27.0	11.1	6.3	14.1
Pension/retirement Package	9.3	1.6	31.3	3.4	12.7	1.6	11.1	4.8	6.3
Wage employment outside agriculture	9.9	12.5	9.0	3.4	7.9	14.3	4.8	7.9	18.8
Sale of forest product sale	2.8	3.1	-	-	-	9.5	1.6	3.2	4.7
Wage from machinery services	1.2	1.6	6.0	-	-	-	-	1.6	-
Renting out draft animals	0.8	-	-		3.2	1.6	-	1.6	-
Marriage gifts	0.6	3.1	1.5	-	-	-	-	-	-
Leasing out land	0.0		-	-	-	-	-	-	-

4.13 Annual income generated by smallholder farmers (all sources)

In this section we analyze the dynamics of income types by value chain in 2016/17 and 2017/18 cropping seasons. Agricultural income was computed as the total value of crop, livestock and livestock products. Income from other sources (mainly off farm) was also computed for each household. This was computed as a summation of all household income obtained from other sources such as businesses, remittances, wage income and gifts, among other things (Zereyesus et al., 2017). Total household income comprised of the summation of agricultural and off farm income.

Results in Table 27 show that farmers in Chiredzi (sugarcane) obtained higher incomes across all the income types. This generally shows that the farmers involved in sugarcane are better off compared to farmers operating in other funded value chains. However, the real incomes for these farmers might be lower than what is presented when variable and fixed cost are considered. Nevertheless, the used measures of income are sufficient to show the difference across districts and the performance of different value chains. Most of the income for Chiredzi (sugarcane) smallholder farmers was obtained through the borrower. Income obtained through the borrower

accounts for approximately 100% of the agricultural income. Similarly, farmers involved in bananas in Chipinge also obtained most of their income from sales made through the borrower in 2016/17 and 2017/18 season. This suggest that in terms of incomes, the sugarcane and banana value chains performed well and had higher welfare gains.

In Mt Darwin, farmers failed to meet the required quality of Mung beans in 2016/17 cropping season therefore obtained less income from sales made through the borrower. In 2017/18, Green Trade did not contract farmers and this subsequently resulted in low sales among mung bean farmers. Michigan pea farmers in Buhera obtained generally low incomes from agricultural activities regardless of the channel used in selling their produce. Their production of Michigan peas was negatively affected by intermittent irrigation water cuts by ZESA due to outstanding electricity bills in both seasons. Compared to all study districts, Murehwa had the lowest agricultural incomes in the two consecutive years. Farmers in Murehwa indicated that their maize production was affected by the army worm infestation, resulting in them getting an average agricultural income of less than US$ 400 in the two seasons. There is need for farmer training in fall armyworm identification and control to avert crop losses (Kumela et al., 2018). Crop insurance mechanisms may be worthwhile to promote among smallholder farmers. Overall, the findings show that sugarcane (Chiredzi), banana (Chipinge), tea (Mutasa) and sorghum (Binga) value chains performed better in terms of income generation across the two years. Michigan Pea Beans (Buhera) value chain was average while sesame (Gokwe North) and maize (Murehwa) did not perform well. The results also highlight the importance of agricultural income to smallholder farmers. In five districts, namely, Chiredzi (sugarcane), Chipinge, Mutasa, Binga and Mt Darwin, the average agricultural income was relatively higher than income obtained from off-farm sources.

Table 27. Level of annual income generated by smallholder farmers (mean)

Value chain – district	*Agricultural income*		*Off-farm income*		*Household income*	
	2017	2018	2017	2018	2017	2018
Banana – Chipinge	3837	3308	611	4800	4448	4412
Sugarcane – Chiredzi	312720	92629	7664	1105	319984	97429
Tea – Mutasa	2669	589	1415	876	4083	1466
Sorghum – Binga	1234	1430	814	863	2049	2293
Mungbean - Mt Darwin	1443	1044	1002	488	2447	1612
Michigan Pea - Buhera	970	1027	1030	569	2000	1495
Maize – Murehwa	330	216	907	257	1237	473
Sesame (Chiredzi/Gokwe North)	688	553	1101	177	1789	730

4.14 Using annual income as a measure of wellbeing

The income generated by farmers was used as a proxy for wellbeing. Farmers' total household income were classified into two categories (i) farmers earning less than US$2 per day and (ii) farmers earning more than US$2 per day. Farmers' that had an annual income that was above US$730 were classified as household living above US$2 per day and likewise, farmers that earned less than US$730 per year were classified as households leaving in extreme poverty (Shaefer & Edin, 2013). We use the poverty measure of $2 a day which is commonly used by World Bank for poverty lines typical of low-income countries (Shaefer & Edin, 2013; Chen & Ravallion, 2007; Ravallion et al., 2009). Table 28 shows the proportion of households above the threshold of $2 per person per day based household income, which includes both agricultural and off-farm income. In almost all the districts, more than 76% of the sampled farmers were living above US$2 per day except for Murehwa and Buhera in 2016/17. This resonates with the Sustainable Development Goal (SDG1) of ending poverty in all its forms everywhere (UNSD, 2016; Pradhan et al., 2017). In 2017/18, the majority of farmers (over 68%) in all the districts were above the US$2 per day poverty threshold except Murehwa and Gokwe North. This implies that most of the farmers in these districts (79% in 2017) and (76% in 2018) were not leaving in extreme poverty when this measure of welfare is used. This reveals that ZADT is efficiently targeting economically active farmers and not the vulnerable farmers who should receive food aid. In column 4 and 5, we account for household size and use per capita income as an indicator of welfare. When this measure is used to classify farmers, the proportion of households above extreme poverty drops to 32% and 45% in

2017 and 2018 respectively. The majority of farmers were living in extreme poverty in the two seasons except for those participating in the banana and sugarcane value chains.

When income obtained from crop sales that were channelled under the borrower is used, the results show that overall, about 34% and 58.6% of the farmers earned more than US$730 in 2017 and 2018 respectively (column 6 and 7). Most farmers in Chipinge (Banana), Chiredzi (sugarcane) and Mutasa (Tea) had higher welfare and lived above US$2 per day in 2018 and 2017. These results demonstrate that banana, sugarcane and tea were the best performing and consistent value chains improving household welfare. These value chains are mostly irrigated and have an assured market which help drive productivity and reduce climate related risks. In Buhera, Mt Darwin, Murehwa and Gokwe North, very few farmers (less than 4%) lived above the S$2 per day in the two consecutive seasons. This suggest that the majority of farmers were living in extreme poverty. These value chains were characterized by many challenges among them late distribution of inputs, erratic rains and poor marketing arrangements and this reduced both productivity and incomes obtained by farmers. Michigan pea farmers in Buhera indicated that they faced challenges with irrigation water supply while mung bean farmers in Mt Darwin indicated that they failed to meet quality requirements in 2016/17 while in 2017/18 there was no off-taker for the bulk of their produce given that Green Trade did not contract farmers. The majority of the poor performing value chains are rain-fed and have no structured and guaranteed marketing channels. The private and public sector should invest in irrigation and market infrastructure complimented by access to market information. Agricultural finance schemes should also strive to include weather based insurance to address the climate risks (Sibiko et al., 2018; Daron & Stainforth, 2014). There is also need to test and include other potential high value crops that are not currently funded under the ZADT facility. For example, groundnuts linked with aflatoxin management and linked to processors like Associated Foods Zimbabwe, biofortified sugar beans (NUA45) which has generated interest among processors such as Cairns Foods. The promotion of new value chains should be supported by vigorous extension.

Table 28. Percentage of farmers living above USD2 per day in 2016/17 (n=513) and 2017/18 (n=481)

	Household income		*Per capita income*		*Income under borrower*	
	2017	2018	2017	2018	2017	2018
Banana – Chipinge	90.8	98.5	49.2	57.1	84.6	98.5
Sugarcane – Chiredzi	87.69	100	96.9	66.7	78.5	100
Tea – Mutasa	77.27	84.4	32.8	38.3	29.2	50.0
Sorghum - Binga	92.19	70.0	18.0	53.7	26.0	42.6
Mungbean - Mt Darwin	82.54	67.9	19.6	52.5	3.6	-
Michigan Pea - Buhera	55.56	67.7	17.7	39.1	3.3	1.7
Maize - Murehwa	65.08	52.9	14.7	23.5	0	-
Sesame	76.56	64.0	10.0	31.6	-	-
Total	78.56	75.7	32.4	45.3	34.4	58.6

4.15 Asset accumulation

4.15.1 Type of assets usable and repairable owned

Table 29 shows status of asset accumulation within a period of 5 years. Survey results show that there is a marginal positive change in terms of asset ownership. These can be attributed to the macro-economic challenges affecting the whole country. The positive change was noticed in assets like cell phones, solar panel, solar lamps, radio, television, ox/Scotch carts, ploughs, boreholes and improved granaries. There is a negative change noticed in assets like tractors, harrows, bicycles and wheelbarrows. The decrease in the number of farmers who use tractors may be an indication of unavailability of tractors or expensive tractor hire costs. The other reason why there is a decrease in the number of farming assets is that most of the assets are worn out and most farmers are failing to fix or replace them. This might be attributable to lack of income to purchase or to service the assets since most of the income obtained from crop sales is used to purchase food items and to cover education expenses. As such, increasing agricultural income might enable farmers to have enough to purchase food, cover education expenses and also remain with some income to invest in agriculture. Another good change is seen in improved granaries. The mean number of farmers who have opted for improved granaries has slightly increased which can mean that farmers have

been taught and they are seeing the benefits of having improved storage structures. Future studies have to also focus on the reasons for observed trends in asset ownership.

Table 29. Asset accumulation over 5 years ago

Asset	Mean of number owned 5years ago	Mean of number currently owned	Change
Plough	0.74	0.80	+
Ox/Scotch Cart	0.43	0.43	
Cultivator	0.14	0.13	-
Harrow	0.16	0.17	+
Tractor	0.09	0.06	-
Wheelbarrow	0.69	0.65	-
Bicycle	0.55	0.52	-
Television	0.37	0.40	+
Radio	0.67	0.74	+
Cell phones	1.46	2.05	+
Borehole	0.04	0.06	+
Water pump	0.05	0.08	+
Water tanks (JoJo)	0.03	0.04	+
Solar panel	0.60	0.87	+
Solar lamp	0.28	0.49	+
Motorcycle	0.04	0.07	+
Improved storage facility	0.14	0.17	+

4.16 Food availability and access at household level

4.16.1 Food security measurements

Household dietary diversity

A modified Household Dietary Diversity Score (HDDS) (Swindale & Bilinsky, 2006) was calculated for each household using data on consumption of food groups over the previous 24 hours. The shorter recall period improves the accuracy of estimates compared with longer recall periods (Swindale & Ohri-Vachaspati, 2004). Food items were categorized into 9 different food groups with each food group counting toward the household score if a food item from the group was consumed by anyone in the household in the previous 24 hours. The modified HDDS, then, is a count variable from 0 to 9. The food groups used to calculate the modified HDDS included: cereals; roots and tubers; vegetables; fruits; meat, eggs and fish; pulses and nuts; milk and milk products; oils and fats; sugar and sweets. Count data model and in particular poisson regression was used for HDDS models.

Household Food Consumption Score

Food Consumption Score (FCS) is a composite score based on dietary diversity, food frequency, and relative nutritional importance of different food groups (Jones et al., 2014; Swindale & Bilinsky, 2006). The FCS is calculated using the frequency of consumption of different food groups consumed by a household during the 7 days before the survey. The consumption frequency of eight food groups (i.e. staple grains and tubers, pulses, vegetables, fruits, meat and fish, dairy products, sugar and oil) is multiplied by a group assigned nutrient weight, and the resulting values are summed to obtain the FCS (Kennedy et al., 2010). This score is then recorded to a three-level categorical variable (poor, borderline, or acceptable food consumption) using standard cut-off values. The assigned weights for each food group are based on the energy, protein and micronutrient densities of each food group. In this study we used the count FCS variable rather than the three-level categorical variable to prevent the loss of data (Jones et al., 2014). The negative binomial regression was used for analysis of FCS.

4.16.2 Effect of credit on food security

Econometric results on the effect of credit access on food security are shown in Table 30. These results suggest that relaxing the credit constraints improved dietary diversity and food consumption in the study area. This resonates with the Sustainable Development Goal (SDG2) of ending hunger, achieve food security and improved nutrition and promote sustainable agriculture (UNSD, 2016; Pradhan et al., 2017). This study therefore provides empirical evidence in favour of policies supporting accessible credit for smallholder households in Zimbabwe. Therefore, programs such as the agriculture credit financing by ZADT need to be strengthened to ensure smallholder farmers have access to credit. Bocher et al. (2017) found similar results that access to credit have a positive impact on food security in Ethiopia. Furthermore, Bidisha et al. (2017) reveals that access to credit tends to improve food security and allows households to achieve greater dietary diversity. Furthermore, results show that education, women empowerment (decision on crop area) and land size had positive associations with food consumption. The results on the positive role of education and land size on household nutrition resonates with Murendo et

al. (2018) for Zimbabwe. Access to information through radio increased food consumption among the smallholder farmers in the study sample.

Table 30. Effect of participation in the value chain financing on household food security

	HDDS		FCS	
	Coef	Std. errs.	Coef	Std. errs.
Credit access	0.113**	0.049	0.100**	0.040
Food aid	-0.027	0.037	-0.035	0.032
Age of head	0.003*	0.001	0.003***	0.001
Gender of head	0.018	0.071	0.122**	0.060
Head marital status	-0.045	0.066	-0.170***	0.056
Head education	0.009*	0.005	0.017***	0.005
Sold crop	0.033	0.046	0.059	0.039
Arable land	0.006**	0.003	0.019***	0.003
Decision on crop to grow	-0.359	0.453	-0.610*	0.345
Decision on crop area	0.366	0.458	0.656*	0.350
Decision on credit	0.041	0.077	0.090	0.065
Own cattle	-0.022	0.036	0.000	0.030
Extension	-0.009	0.038	-0.037	0.032
ICT	0.016	0.042	0.022	0.035
Radio	0.028	0.037	0.058*	0.031
Demonstration	0.024	0.037	0.050	0.032
Field day	0.007	0.040	0.039	0.034
Constant	1.577***	0.122	3.404***	0.105
Observations	481		481	
P-value	0.018**		0.000***	
Log likelihood	-993.4		-2071.5	

*, **, ***. Statistically significant at the 10%, 5%, and 1% level, respectively.

Table 31 shows estimates of the effect of credit obtained in the past 12 months (through borrowers) on household nutrition. The amount of credit borrowed in the past 12 months had no significant effect on dietary diversity and household food consumption score. Given that this is a short time period data, the gestation period of the credit to produce desirable food security effects may be quite short. In the next section, we account for the amount of credit initially borrowed and assess its effect on household nutrition.

Table 31. Effect of credit borrowed last 12 months on household food security

	HDDS		FCS	
	Coef	Std. errs.	Coef	Std. errs.
Credit volume last year	0.006	0.019	-0.020	0.015
Food aid	-0.039	0.063	-0.032	0.051
Age of head	0.002	0.003	0.003	0.002
Gender of head	-0.002	0.140	0.284**	0.111
Head marital status	-0.037	0.139	-0.363***	0.109
Head education	0.009	0.009	0.017**	0.007
Sold crop	0.052	0.077	0.068	0.061
Arable land	0.002	0.009	0.018**	0.008
Decision on crop to grow	-0.349	0.465	-0.620*	0.338
Decision on crop area	0.396	0.476	0.727**	0.347
Decision on credit	-0.072	0.123	-0.033	0.099
Own cattle	-0.012	0.064	0.075	0.051
Extension	0.042	0.071	0.094*	0.057
ICT	-0.010	0.068	-0.009	0.055
Radio	0.047	0.063	0.035	0.050
Demonstration	0.050	0.063	0.090*	0.051
Field day	-0.040	0.072	-0.019	0.059
Constant	1.752***	0.247	3.635***	0.199
Observations	170		170	
P-value	0.989		0.008***	
Log likelihood	-346.329		-718.522	

*, **, ***. Statistically significant at the 10%, 5%, and 1% level, respectively.

Table 32 shows estimates of the effect of initial amount of credit borrowed on household nutrition for borrowers only in the last 12 months. Regarding our key policy variable of interest, results from the poisson and negative binomial regression shows that credit amount had insignificant effect on household dietary diversity and negative effect on food consumption. A unit increase in the initial credit leads to a 1.3% decrease in household food consumption score. These results are partly explained by the fact that some farmers despite low productivity had to repay back the loan. In other cases, the inputs costs obtained through borrower were more expensive compared to those on the normal market channels, for example tea.

Table 32. Effect of volume of credit initial borrowed on household food security

	HDDS		FCS	
	Coef	Std. err.	Coef	Std. err.
Credit volume (initial amount)	-0.006	0.009	-0.013*	0.007
Food aid	-0.036	0.044	-0.030	0.035
Age of head	0.003	0.002	0.003***	0.001
Gender of head	-0.031	0.080	0.074	0.064
Head marital status	-0.017	0.075	-0.134**	0.059
Head education	0.012*	0.006	0.018***	0.005
Sold crop	0.045	0.051	0.084**	0.041
Arable land	0.005	0.003	0.018***	0.003
Decision on crop to grow	-0.391	0.455	-0.670**	0.327
Decision on crop area	0.410	0.463	0.726**	0.334
Decision on credit	-0.000	0.092	0.056	0.074
Own cattle	-0.007	0.041	0.035	0.033
Extension	0.004	0.043	-0.010	0.035
ICT	-0.014	0.048	-0.018	0.039
Radio	0.029	0.042	0.054	0.034
Demonstration	0.014	0.042	0.058*	0.034
Field day	-0.006	0.045	0.016	0.036
Constant	1.777***	0.149	3.598***	0.121
Observations	358		358	
P-value	0.468		0.000***	
Log likelihood	-736.545		-1534.851	

*, **, ***. Statistically significant at the 10%, 5%, and 1% level, respectively.

5 CONCLUSION AND RECOMMENDATIONS

5.1. Summary of findings

This study highlighted the impact of the ZADT Fund on smallholder farmer's livelihoods, agricultural productivity and food security in Zimbabwe in selected value chains, namely: sorghum, sugarcane, bananas, sesame maize, Michigan pea beans, tea and mung beans. The study mainly focused on credit that was obtained by farmers through borrowers. The notable impacts of the ZADT Fund are summarized below:

i. Improved access to credit

The ZADT Fund improved smallholder farmer's access to credit, particularly for women. Approximately 52% and 44% of the farmers that obtained the ZADT credit were females in 2016/17 and 2017/18 season respectively and this is in tandem with Sustainable Development Goal (SDG5) of promoting gender equality and women empowerment. The conditions to get the credit were non-discriminatory and favoured both women and men given that farmers were required to demonstrate their ability to produce crops through providing evidence of access to reasonable

arable land, having animal (draught power) to use, and also belonging to a group. There were rare cases in which farmers were asked to provide collateral that possessed monetary value such as houses, vehicles and bank statements. Results also show that farmers have limited access to credit from other sources. This reflects the importance of the ZADT facility to smallholder farmers.

ii. Improved access to extension

Farmers that participated in programmes financed by the ZADT Fund had better access to extension services. In addition to government extension support services that are provided to all farmers, about 42% and 43% of farmers that participated in the ZADT funded programme in 2016/17 and 2017/18 obtained additional extension support from borrowers respectively. Availing extension support helps in building capacity among farmers and also improves productivity. This has spill over effects towards household welfare and economic development.

iii. Contribution to incomes and market access

The ZADT funded programme was instrumental in creating a stable, viable and guaranteed market for smallholder farmers in the two cropping seasons. Crop sales from 7 value chains that were channelled through ZADT funded value chain actors contributed around 58% to total farmers' crop revenue generated in 2016/17 season. In 2017/18 season, the sales contributed to 75% of the crop revenues realised from 5 value chains. The regression results also showed that an extra dollar obtained from ZADT facility increased sugar cane income by 95.1% among participating farmers in Chiredzi. In addition, an extra dollar obtained from ZADT facility increased red sorghum income by 16.9% in Binga. The results also show that sugarcane (Chiredzi), and red sorghum (Binga) value chains performed better in terms of income generation. An additional year of borrower-farmer relationship increased income among sugarcane and Michigan pea farmers by 14.5% and 45.2% respectively. Nurturing and maintaining long term relationships between borrowers and farmers is crucial to enhancing farmers' welfare. Income obtained through the borrower accounted for a greater proportion of income that was obtained from all crops sales. Mung beans (Mt Darwin) was one of the value chains that did not perform well in both 2016/17 and 2017/18 seasons. The poor performance was mostly attributed to delays in providing inputs to the farmers. Sesame value chain was not functional in 2016/17 season, therefore farmers did not sell any crops through the borrower. Sidella Trading did not maintain the relationship with the farmers after the maturity of the facility. Again in 2017/18, Sidella did not provide any credit to

sesame farmers although they bought the produce. Therefore there was no credit relationship between Sidella and farmers in Gokwe North. Farmers grow sesame using their own seed inputs and sell the produce to Sidella. Overall, approximately 34% and 59% of the households earned more than US$2 per day from the sales that were channelled through the borrower in 2016/17 and 2017/18 season respectively.

iv. Contribution to food security and livelihoods

Results show that access and volume of the credit obtained under the ZADT funded programmes had positive effects on dietary diversity and food consumption. Most of the income generated from crop sales under the ZADT facility in 2016/17 (36%) and 2017/18 (28%) were used to purchase food and subsequently improves dietary diversity. The regression results showed that a unit increase in the initial credit leads to a 2.4% and 3.7% increase in household dietary diversity and food consumption score respectively in 2016/17. In 2017/18, credit access increased household dietary diversity and food consumption score by 13% and 10% respectively. Some of the farmers used the income to pay for school fees. This has a positive and long-term effect on human capital development. Farmers also reinvested income into agricultural activities (20%) and (18%) for 2016/17 and 2017/18 seasons respectively. The ability to reinvest ensures sustainability of farm enterprise. These results are in line with Sustainable Development Goal (SDG2) of ending hunger, achieve food security and improved nutrition and promote sustainable agriculture. In this regard, the fund is contributing to SDG2.

v. Sustainability of the established agribusiness links

Despite the fact that some of the facilities had matured at the time of the study, Matanuska (banana value chain) maintained links with farmers. Tea farmers managed to negotiate and entered a contract with Eastern Highlands Plantation after the collapse of Hippocrene. This facility demonstrate that farmers have been capacity build through the ZADT facility for forge their own future partnerships, a key indication of sustainability. Only Green Trade (Mung beans value chain) did not maintain the links with farmers. This suggests that there are greater chances of continuity after the project life. The duration of relationship with borrower had a positive and significant association with crop income for sugarcane and Michigan pea farmers. An additional year of borrower-farmer relationship increased income among sugarcane and Michigan pea farmers by

15% and 45% respectively. Therefore nurturing and promoting long-term relationships between credit providers and farmers is important to enhance household welfare.

5.2. Factors undermining the impact of ZADT facility

One of the factors that undermined the impact of the ZADT facility was the delay in disbursing the funds (inputs). Approximately 37% of the farmers highlighted that they encountered delays in receiving credit/inputs in both the two cropping seasons. Delays in giving farmers inputs / credit results in late planting which usually leads to yield losses, especially for rain fed cropping systems.

Nearly 31% and 45% of farmers indicated that the repayment procedure and conditions were not clearly articulated to them in 2016/17 and 2017/18 seasons respectively. There is need for borrowers and farmers to articulate and agree on clear loan repayment requirements to build trust and improve on the farmer-borrower relationship. Overall, there was lack of youth participation (defined as individuals under the age of 35) in the ZADT funded programme and this undermines sustainability and continuity of agribusinesses in the long run.

Weather related risks for rain fed cropping continue to hamper production and productivity. There is need for investment in risk mitigation strategies, for example weather insurance index and irrigation. In addition, soil and water conservation techniques are crucial to enhance soil moisture. This resonates well with the two financial products that were commissioned by ZADT in 2018 - Access to Clean Technology product and the Climate Smart Agriculture product (ZADT, 2017). There is need for creating awareness of these two products among all farming stakeholder so as to create demand. After some time, it is also prudent to evaluate the impact of these newly introduced products on productivity, income and food security. For cereals, the majority of farmers reported yield losses due to fall army worm, and this subsequently reduces household own consumption as well as the marketable surplus that could have been sold and earned income. This subsequently results in food insecurity.

5.3. Recommendations

The recommendations presented aims at making sure that the identified positive contribution of the ZADT facility are maintained and improved. Suggestions on ways to address factors undermining the impact of the ZADT facility are also presented. Basing on the 2017 and 2018 study findings, key recommendations for the ZADT funded programme includes:

Improve inclusive credit access and increase volumes

There is need to continue improving inclusive credit access and the amount of credit offered to farmers as well as improve market linkages opportunities for farmers who are supported by the funded agricultural value chain actors. The results showed a positive relationship between amount of credit given to farmers and crop income in 2016/17 and 2017/18 season. An additional dollar borrowed by sugar cane farmers led to a 56% and 95% increase in crop income in 2016/17 and 2017/18 seasons respectively. The extra dollar obtained from ZADT facility increased red sorghum income by 17% in Binga. These results suggest that increasing value of the credit will improve crop production and incomes. Increasing agricultural incomes might also enable farmers to reinvest in agricultural activities, increase production scale, and benefit from economies of scale.

Market linkages could be improved by encouraging contractual arrangements that are beneficial to both the borrower and the farmer. These contractual arrangements should be in the form of written contacts as they show better levels of commitment. About 52% and 44% of the farmers that accessed credit from ZADT facility were females in 2016/17 and 2017/18 respectively and the conditions to obtain the credit were accommodative. Interventions that continue to improve credit access among women smallholder farmers are crucial. The ZADT fund should also strategically link and strengthen ISAL groups where the majority of members are women.

Financing sustainable crop and livestock enterprises

The performance of some of the value chains, in particular mung beans and sesame were not impressive according to the farmers interviewed in the two consecutive seasons. Farmers highlighted that these were new crops and need a lot of extension backstopping and well organized and functional markets. In addition, farmers perceived that it was better for borrowers to finance commonly grown and reared crops and livestock, for example maize, sugar beans, sorghum, groundnuts, small stock and cattle for sustainability. It will be easier for farmers to produce good quality of the crops they are used to grow. In addition, producing crops they are used to growing would enhance chances of continuity. Some of the crops commonly grown by farmers that have potential include groundnuts and sugarbeans. For example, there is huge demand for aflatoxin free groundnuts by processing companies in Zimbabwe as well as biofortified sugarbeans by Cairns Foods and Harvest Plus. Biofortifed sugarbeans have high zinc and iron which are important for child and maternal nutrition and is being promoted extensively by donors, ministries of health and

agriculture. In addition, farmers in Mt Darwin expressed high interest in sugar beans compared to mung beans. In South Western parts of the country which lie in the sweet veld, for example Binga and Chiredzi there is scope for financing livestock enterprises for example goat improvement programmes and beef feeder finance schemes. However, whilst financing commonly grown crops is a good strategy it should also be noted that the off-takers who have contracted farmers have identified unique markets which require these new (emerging) value chains. The advantages of new crops to off-takers is that marketing will be minimal. Financing common crops has the disadvantage of free riders – buyers who want to come to offer higher buying prices to cause the farmers to side market. If borrowers finance new value chains, these should be supported by extension.

Relevant and timely extension and farmer training

There is need for borrowers, private and public extension to continue providing extension support to farmers. Alternatively, farmers could be encouraged to form associations which would be used as a vehicle for providing training. One example is through the ISAL groups which can be directly linked to the ZADT facility. Results show that fertilizer application increased crop productivity. There is need for extensive farmer training on Integrated Soil Fertility Management Practices, for example Microdosing and conservation agriculture that enhance soil fertility. Extension support is usually associated with improved technology adoption and subsequently increases productivity. Furthermore, providing extension support may be used as a vehicle to monitor quality of the product during growth so as to take corrective action in time and avoid loses. Support provided by borrowers was mostly in the form of extension and there were few instances where farmers received training on business management, record keeping, budgeting and marketing. Suspicion about lack of transparency is inevitable if farmers are not able to read and correctly interpret summary of their financial statements (transactions). Comprehensive, business-oriented training is likely to enhance farmers' decision making (judgement) and also help them understand all deductions made on their revenues. In addition to general extension, there is need for both the private and public sector to provide training on financial literacy, post-harvest losses management, fall armyworm control and business entrepreneurship. In addition all pluralistic extension methods including ICT linked extension, community based advisors should be used to disseminate agricultural, market and price information to farmers.

Transparent and efficient costing system

Results from the study indicated that some farmers had concerns about the cost of inputs obtained under the ZADT funded programmes. There were cases in 2016/17 where farmers had to pay about 28% more than what they would have paid if they had obtained inputs directly from agro-dealers. In 2017/18, there were no more cases of farmers paying higher input prices through the borrower than the market. There is need to foster transparent and efficient ways of providing the services to farmers at a realistic cost, such that the cost under the facility is not way above the cost of obtaining inputs directly from agro dealers. The program should strive to provide inputs at a cost that allows farmers to pay at most 15% more than the actual market price after factoring in interest, administrative and transport cost.

Timely disbursement of inputs (credit) and prompt payment to farmers

The ZADT Fund was successful in financing the respective value chains. However, most of the farmers raised concerns about the timing of the credit from the borrower regardless of the type of value chain. Timely disbursement of inputs permits farmers to plan their cropping mix efficiently, plant in time thereby enabling them to utilize limited rains. This also helps in efficient farm resources allocation which will in turn ensure viable farm enterprises.

Furthermore, to enhance convenience and improve welfare of farmers, borrowers should make prompt payments to farmers after collecting the harvested crops. Avoiding delays in settling the payments also improves farmers' confidence on the borrower. Building farmers' confidence and trust is necessary if sustainable relationships are to be attained. Given the high mobile phone penetration in the country, electronic farmer payments through mobile money can also be used to ensure timely farmer payments

Participation of women and youths in the programme

The ZADT Fund was successful in addressing gender inclusivity, given that most women participated in the value chains in the two consecutive years. This is clear testimony that the fund is contributing to Sustainable Development Goal (SDG5) of promoting gender equality and women empowerment. However, overall participation of youths in this credit programme was limited (less than 10%) in the two survey periods. Most of the farmers interviewed in the study were beyond 35 years of age indicating that the majority of the active members in the programme

were approaching the economically inactive group. There is need to make deliberate efforts to promote youth participation in the agricultural programmes in order to ensure maximum productivity and continuity. The youth may have a greater potential in exploring other agribusiness opportunities. Although, borrowers fund specific value chains, ZADT fund can also deliberately fund business enterprises that are pro-youth and don't require land ownership rights, for example value addition, transport and aggregation – peanut butter processing, beef feeder finance schemes, aquaculture and butchery.

5.4. Conclusion

The study findings indicated that ZADT facility was successful in availing credit to resource constrained smallholder farmers and in enhancing gender equality through women participation in the credit program in the two cropping seasons. The ZADT programme had a positive impact on creating a viable market for smallholder farmers, improving agricultural productivity, incomes and food and nutrition security.

To consolidate the welfare gains of the ZADT Fund there is need for timely disbursement of inputs, extension and entrepreneurship training, transparent cost structures and timely payment of farmers. Maintaining of long-term relationship between credit providers and farmers is crucial for sustainability. There is also need for borrowers to reconsider the viability of two value chains – sesame and mung beans given their consistent poor performance. Potential crops that borrowers can be finance instead include biofortified sugar beans and groundnuts, which have ready markets in the country and regionally as well as livestock enterprises for example beef feeder finance and small stock rearing. Given the positive contribution that the facility has, there is need to continue availing the credit facility to farmers. Policies that strengthen the functioning of pro-youth and pro-gender agricultural credit need to be promoted.

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