Irish Aid Learning Platform on Climate Change and Development

Ethiopia Case Survey Report

Lake Hawassa Longitudinal Study

Irish Aid

Sam Barrett

International Institute for Environment and Development

Summary

This report provides summary findings from the 4rd survey of the Lake Hawassa longitudinal study of livelihood-based climate adaptation interventions. The study compares intervention and counterfactual households between 2015-2018 on key outcome indicators. The numbers of observations now available are sufficient for a direct comparison of matched households (previously a general control/counterfactual groups comparison) and a more accurate comparison focusing on specific interventions is now possible. **Therefore, it is now possible to compare matched intervention and counterfactual households by intervention type based on an aggregation of the 4 surveys conducted**. **This means that the findings of intervention impact are far more robust than in previous iterations of the report.** After summarizing the main points, some recommendations are provided. The 5th survey is due to be completed in November 2017.

Income: Sustainable intensification households outperform their matched counterfactual households in relation to agricultural income (+1,629 Birr). Income generated by households practicing irrigated vegetable farming significantly outperforms matched counterfactual households (+8,186 Birr). SL+PC households are also performing well compared to matched counterfactual households in relation to livestock income (+1,241). Income from conservation agriculture is less than from the control by matched counterfactual households (-6,960 Birr[1]). Income from the livestock intervention is higher for treatment households (+1,127 Birr).

Trade-Offs: The income trade-off analysis shows different interventions encouraging households to engage in certain livelihood activities over others, or achieve synergies. Sustainable intensification interventions do enable synergies between agriculture and livestock income, in addition to emerging evidence that such interventions indirectly facilitate, or at least don't inhibit, wage and business income generating activities. For SL+PC households, trends indicate that nearly all households focus on either agriculture or livestock, suggesting synergies are a challenge. Though SL+PC households are taking more livestock to market than counterfactual households. Also, the same tendency to trade-off different income sources for business income exists, particularly trading agriculture off for other non-farm opportunities. But in a few instances synergies have been achieved by SL+PC households, in contrast to counterfactual households. Conservation agriculture interventions should impact on agriculture and livestock income, and enables farmers to raise both income streams simultaneously. These households tend to achieve higher livestock and agriculture income when compared to counterfactual households, but largely do not register off-farm income streams.

Production: To standardise total crop production, the monetary value of all harvested crops was calculated using market prices. Sustainable intensification households produced more than the counterfactual in all surveys, particularly survey 1, 2 and 3. Only in a few instances did counterfactual households yield a higher value crop. Some of the highest returns were achieved by households practicing sustainable intensification. Irrigated vegetable interventions have largely removed the seasonality of cropping. The initial survey shows irrigated vegetable households performing approximately as well as the counterfactual households, while the 2nd survey records production far higher value than the counterfactuals in the rainfed season. Finally, conservation agriculture households performed similarly to counterfactuals, despite sporadic higher and lower production, possibly attributable to the fodder component that was given to livestock.

Connections between Production, Consumption and Income: The interactions between production, consumption and income are explored. As intuition indicates, higher production results

[1] Note that all figures in this paragraph are based on an aggregation of the 4 surveys (2015-2017)

in higher income. Though, there is a tendency for consumption to have some inhibiting influence on income (or vice versa), but exceptions of synergistic outcomes exist amongst the interventions (e.g. sustainable intensification households). The most surprising finding is that interventions seem to be changing the way that farmers use markets to sell produce – there is little or no link between the level of crop sales and crop surpluses (i.e. produce minus sales) for intervention households, but there is a strong positive association for counterfactual households. Counterfactual households seem to be more conscious to ensure more of a balance between sales and left over crops, and intervention households are more likely to sell more of their produce.

Measuring Climate Resilience: The climate resilience of improved maize varieties is measured. Aggregate rainfall and historical crop yield data are combined to establish the yield expected given a level of rainfall in a cropping season, which is compared to the actual maize yield of households in receipt of improved seeds and various agricultural support services. Results are positive. In Wondo Genet, the difference between expected and actual average household yields were +1,495 kg per hectare (+30%) in 2015, and +1,432 kg per hectare (+81%) in 2016. In Hawassa Zuria, the difference between expected and actual average household yields were +833 kg per hectare (+15.1%) in 2015, and +963 kg per hectare (49.5%) in 2016.

Recommendations:

1. It is clear from the surveys and analysis that households practicing the sustainable intensification technology consistently perform well relative to counterfactual households in terms of production, income and nutrition. There is evidence the intervention steadily intensifies agricultural and livestock production, income and the climate resilience, while balancing demands with on-farm consumption. Lessons can be taken from the implementation of this intervention, and there is justification to expand coverage and to enable larger numbers of households to benefit.

2. Conservation agriculture households are assessed as not performing well, now that the counterfactuals are more robust. Many counterfactual households function better in relation to agricultural production and income generation, as well as alternative livelihoods. This may be due to the longer learning process of conservation agriculture, but there is a need to identify factors inhibiting production and income.

3. SL+PC households perform marginally better than counterfactual household in relation to livestock and agricultural income. In addition, evidence is emerging that such households can diversify livelihoods easier, which suggests more synergies between farm and off-farm livelihood activities. SL+PC interventions are enabling some agricultural and livestock production, while maintaining diversified livelihoods.
4. Irrigated vegetable households are able to circumnavigate drought and other aspects of climate variability and households produce crops in the dry season. Further investigation is required to establish the effect on local vegetable markets to ascertain the sustainability of the practice.

Introduction

'Improving Smallholder Livelihoods and Resilience in the SNNPR (Southern Nations Nationalities and Peoples' Region) and Oromia Regions through climate smart agricultural economic development' is a consortium project funded by Irish Aid and managed by SOS Sahel, Vita, Self-Help Africa and Farm Africa. The project aims to alleviate poverty and foster resilient/sustainable livelihoods for vulnerable Smallholder Farmers (SHF) through climate-smart agriculture. The International Institute for Environment and Development (IIED) and Echnoserve Consulting are conducting a longitudinal study (2015-2018) in the project area of Lake Hawassa watersheds. The study develops evidence around the effectiveness of project components – such as building climate resilience in the livelihoods of SHF around watersheds – for the purposes of institutional learning and the efficacy of future climate adaptation/resilience programming. As such, it broadly follows the twin track (Track 1 & 2) methodology of the 'Tracking Adaptation and Measuring Development' (TAMD) framework by assessing institutional climate risk management and contributions to resilient development at the community/household-level (Brooks et al. 2011).

This survey report outlines some preliminary findings from the first and second year of data collection (4 surveys) around the effectiveness of activities. Program activities include: 1) sustainable crop intensification; 2) Savings, Loans, Pullets and Cockney (SL+PC) for women; 3) conservation agriculture; and 4) irrigated vegetables. The analysis enables documentation of the effectiveness of technology improvements in developing the climate resilience of SHF via production, income and nutrition. The main research question in this survey report is:

1. What impact are project activities having on the production, income and nutritional status of households in Hawassa, and thus their resilience to climate change?

The document is in the following order: section 1 explains the methodology used to measure impact from the natural resource component; section 2 sets out the findings related to income, and disaggregated according to intervention type; section 3 explore the income trade-offs encouraged by different interventions; section 4 investigates the production and nutrition performance of different intervention types; section 5 illustrates the complex interactions between production, consumption and income; section 6 provides updates on measuring the resilience of improved maize varieties; section 7 outlines some challenges and limitations of the work, and the workplan and budget.

1. Methodology

This section explains the methodologies used in the survey report. The first sub-section outlines the basic matching procedure that tries to account for biases when comparing intervention and control (from here on in, mainly referred to as counterfactual households). The second sub-section lists the different forms of descriptive statistics used to explore the survey data.

Matching Approach

The matching approach reduces the likelihood results are biased by alternative explanations for outcomes. This required matching households receiving climate smart agriculture interventions with households who did not get the intervention (counterfactual households), but nonetheless have similar farm and household capacity characteristics. Table 1 shows how matching is done

based on farm capacity to produce, generate income and supply nutrition to the members of the homestead; preference was given to households matching on the primary drivers of capacity in this group – in particular, livestock value, farm asset value and irrigation practices. In addition, the two groups were also matched based on kebele and woreda, thus reducing biases associated with bureaucratic administration, altitude, rainfall and spatially-defined political factors.

Table 1: Variable Matches Across Treatment and Counterfactual Households

		Treatment Group	Livestock	Farm Assets	Irrigation	Farm Size	Adu/Ch Ratio	Fertilizer	Market distance	**Control Group**
Wondo Genet	Wotera Kchema	**T1**	VL	M	Y				L	**C1**
		T2	L	M	N				L	**C2**
		T3	H	VH		VH	VL			**C3**
		T4	M	M	Y				L	**C4**
		T9	VH	M		L	L			**C9**
		T10	VH	L	Y	H				**C10**
		T11	L	VL	Y		VH			**C11**
		T12	VH	M	Y			VH		**C12**
	Yowo	**T5**	L	L	Y	L				**C5**
		T6	L	M	Y					**C6**
		T7	M	L	Y	VH				**C7**
		T8	H	M	Y				M	**C8**
		T13	M	L	Y	L		L	M	**C13**
		T14	VH	VH	Y	M				**C14**
		T15	VH	VH	Y			VL		**C15**
		T16	L	L	Y					**C16**
Hwassa Zuria	Kajema Emblo	**T17**	L	VL	N		H			**C17**
		T18	L	L	N		M			**C18**
		T19	H	VL	N	L	M			**C19**
		T22	L	VH	N	L		M	H	**C22**
		T26	M	H	N		H	L	H	**C26**
		T28	H	VL	N	L	M		H	**C28**
		T29	M	VH	N	L		H		**C29**
		T30	VH	VH	N	VH		VH		**C30**
	Lebu Keromo	**T20**	H	L	N				M	**C20**
		T21	VL	VL	N		M	L		**C21**
		T23	VL		N		H	L		**C23**
		T24			N		M		VL	**C24**
		T25	VL	VL	N	VL			VL	**C25**
		T27	L	H	N		VL	L		**C27**
		T31	H	H	N	VL				**C31**
		T32		H	N	L		VH		**C32**

T= Treatment C = Control VH = Very High H = High M = Medium L = Low VL = Very Low

Methods

The following methods were used to illustrate the trends on the survey data:

Section 2: income is shown using basic tabulation of mean calculations, which is disaggregated according to intervention type, and t-test statistics are calculated to establish whether differences between the groups are statistically different from zero. Additional line charts are used to illustrate trends in the data;

Section 3: trade-offs are shown using scatter plots. This enables the relationships to be displayed between different income sources, and which are also disaggregated according to intervention type;

Section 4: production data is shown graphically by using line charts. This enables the trends in the data to be illustrated;

Section 5: the interactions between production, consumption and income are complex and vary across intervention types and counterfactuals. These relationships are illustrated using multiple bar charts set out in a 5x6 matrix;

Section 6: the measure of resilience is developed by the establishing relationship between rainfall and maize yield, and using this to compare estimated with actual yield in intervention households. This is shown using a line chart.

2. Income

Table 2 shows the average agricultural, livestock and total income for intervention and counterfactual households. The top 2 rows set out results from surveys in November 2015 and 2016, and which proceed left-to-right with 3 intervention types and the counterfactual. The bottom row sets out the 3 interventions and counterfactual group, but as an aggregated value based on all 4 surveys. The main difference of the bottom row value being that these intervention and counterfactual households are matched based on the specific characteristics of the intervention type households, rather than a generic counterfactual that pooled all such households into a single group.

The linkages between interventions and performance measures are as follows: sustainable intensification, conservation agriculture and irrigated vegetables interventions are designed to improve agricultural income, as well as production and nutrition; while SL+PC interventions should impact on livestock income, as does conservation agriculture through the fodder components. The findings are as follows: the previous strong performance of conservation agriculture (+11,053 Birr) households in generating agricultural income is now reversed to a relative underperformance when compared to the matched counterfactual households (-6,960 Birr), but livestock income remains strong relative to the counterfactual households (+1,127 Birr); sustainable intensification households are still outperforming their matched counterfactual households in relation to agricultural income (+1,629 Birr), and the margin is broadly similar to the previously used aggregated counterfactual group (+2,069 Birr); households practicing irrigated vegetable farming are significantly outperforming matched counterfactual households (+8,186 Birr); SL+PC households are also performing well compared to matched counterfactual households in relation to livestock income (+1,241), which reverses previous under-performance (-580 and -235 Birr).

Figures 1 and 2 graphically display the distribution of agricultural and livestock income of intervention types and their corresponding matched counterfactual households (placed in ascending order from left-to-right). The top graph in Figure 1 shows the agricultural income from conservation agriculture. The counterfactual households performed systemically better at the point of the initial survey, with no intervention households outperforming any counterfactual household. This improved in Survey 2 and 3 as all households managed to take crops to market, but most of the best performing counterfactual households still managed higher incomes than those practising conservation agriculture. Finally, Survey 4 repeated the systemic outperformance of intervention households by counterfactual households.

Table 2: Average Farm, Livestock and Total Income (Birr) Across Intervention Types without Irrigated Vegetables

	Avg. Income	*Sust. Crop*	*Control*	*Conserv. Ag.*	*Control*	*SLPC+PC*	*Control*	*Irr. Vege.*	*Control*	*Control (All)*
Nov. 2015	Crop	3408		5768		6021				6187
	Livestock	1311		1732		431				1011
	Total	8183		9276		10044				9542
	N	8		8		16				32
Nov. 2016	Crop	7091		16075		3830				5022
	Livestock	4243		5493		1405				1640
	Total	12103		22900		7188				11355
	N	8		8		16				32
All 4 Surveys (Exp Irr. Veg.)	Crop	7296	5667	10019	16979	3529***	877***	9518***	1332	
	Livestock	3419**	992**	3456	2329	2621	1380	4316*	2313	
	Total	11890	8870	14785**	26820**	7557	5655	20286***	5822	
	N	32	32	32	31	63	59	40	40	

ttest statistics were conducted to determine whether the mean values between the two groups are statistically different from zero. This tests whether the difference in means is different from zero by chance variation (meaning one or two values may have a significant effect on mean values), or whether it is more likely based on a pattern in the distribution. Statistically significant differences are boxed off, with the following level of statistical significance stated - ****p* < .01, ***p* < .05, **p* < .1*

Figure 1: Agricultural Income (4 Surveys) for Sustainable Intensification and Conservation households when Compared to Counterfactual Households

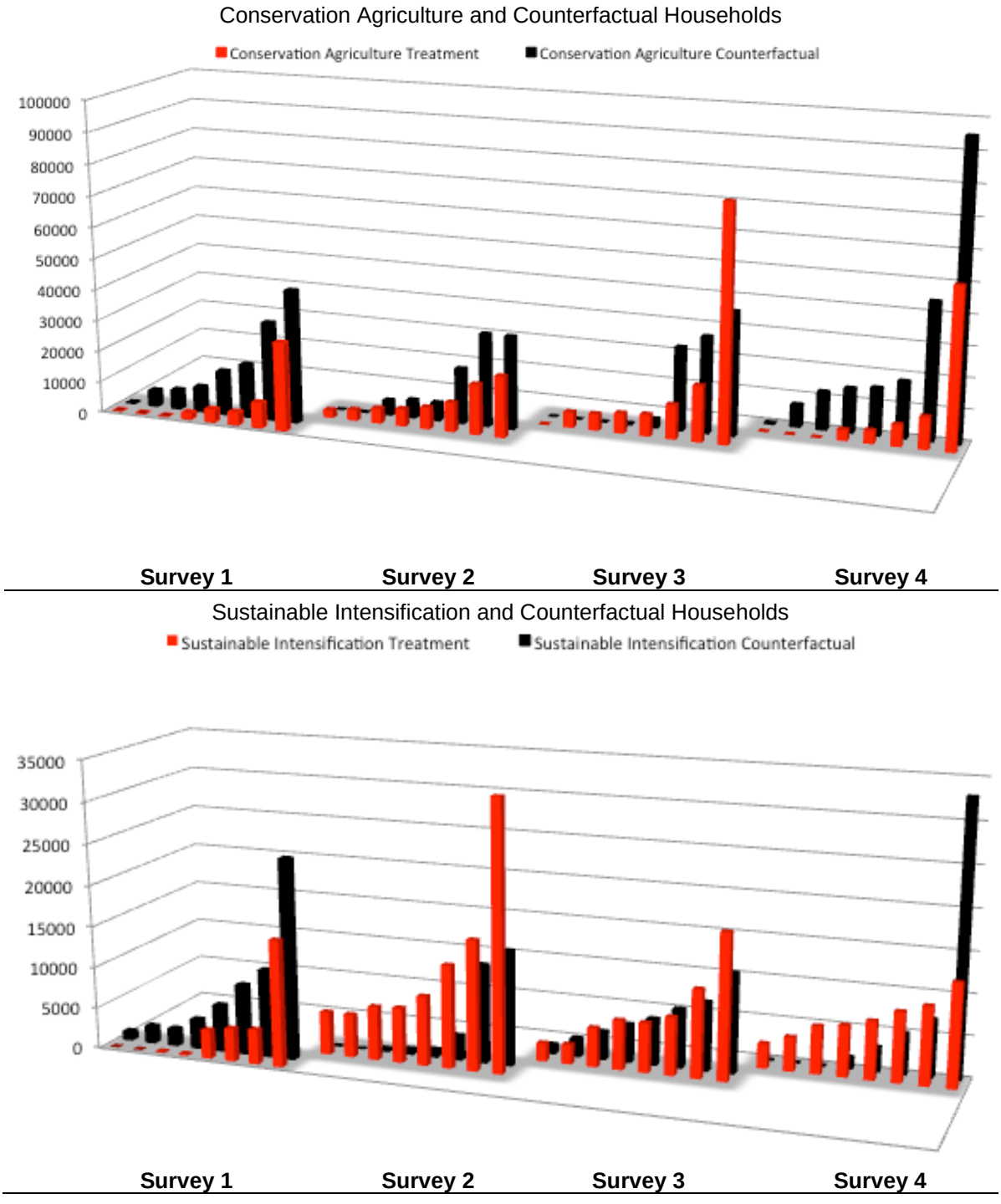
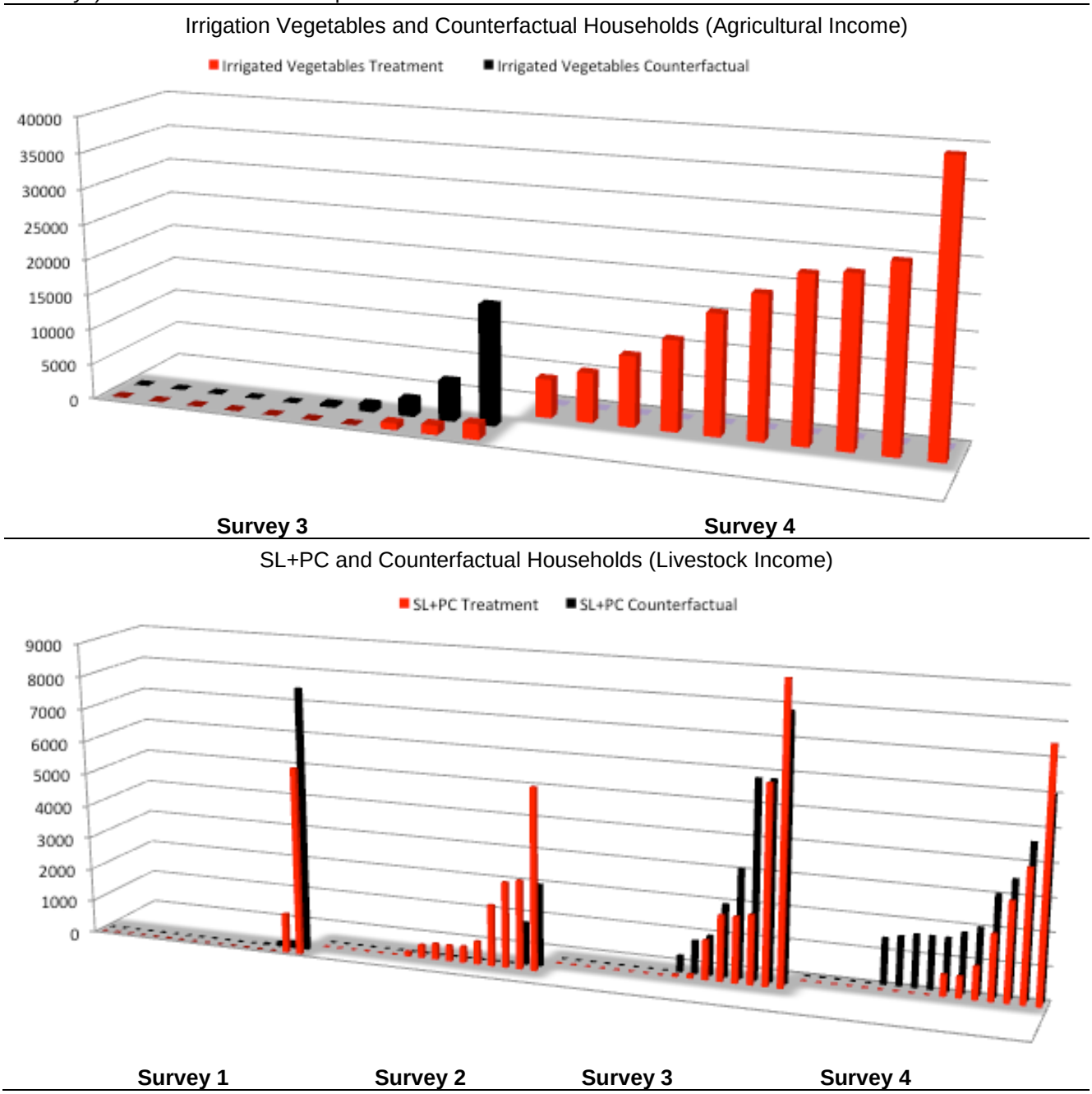


Figure 2: Agricultural (top) and Livestock (bottom) Income for Irrigated Vegetable (2 Surveys) and SL+PC (4 Surveys) Households when Compared to Counterfactual Households



The bottom graph in Figure 1 illustrates the agricultural incomes of households practising sustainable intensification, and their matched counterfactual households. The intervention performs strongly in all surveys, aside from the first in November 2015. In particular, the period from December to June are times of harvest of Maize and Harricot bean, and new seeds and farming practices are resulting in all households managing to take crops to markets, and some to generate incomes many multiples higher than counterfactual households.

Figure 2 shows the agricultural income in the past 12 months from households practising irrigated vegetable farming (top), and the livestock income of households receiving the SL+PC intervention type (bottom). Irrigated vegetable farming is having the largest impact on agriculture incomes, once again showing incomes numerous multiples higher than counterfactual households. This is especially the case between December 2016 and June 2017, where counterfactual households failed to take any crops to market, and yet the bi-annual agricultural incomes of irrigated households ranged from 6,000 to 40,000 Birr.

The income of SL+PC households is broadly similar to counterfactual households. The first survey in November 2015 showed only a few households managing to take livestock/livestock produce to market. Survey 2 recorded a marked improvement for SL+PC households, as 10 of 16 households secured some income, representing a broad out-performance of counterfactual households. In survey 3, SL+PC and counterfactual households managed to generate significant livestock income, with 4 of the 16 households in each category securing +2,000 Birr. In the final survey (June 2017), counterfactual households secured more income at the lower end of the distribution, but from the mid-range of the distribution upwards, the SL+PC households performed equally as well.

3. Income Trade-Offs

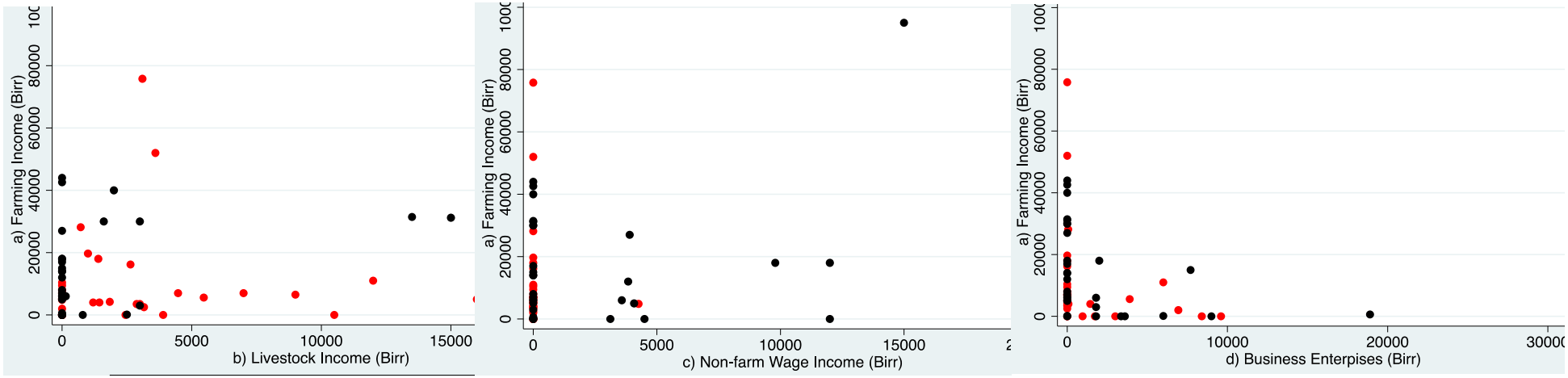
The survey data enable the identification of trade-offs that smallholder farmers encounter when engaging in different intervention activities, because time spent on intervention activities has an opportunity cost. For instance, livestock management for women may require additional labour time that discourages non-farm wage labour opportunities; while, climate smart farming typically diverts time and energy from brokerage businesses or other alternative livelihoods. The following sub-sections explore the trade-offs that different interventions incentivize by using scatterplots to compare different income streams.

Conservation Agriculture

The top row of Figure 3 shows the trade-offs in different income sources for conservation agriculture households. Observable from the left-hand graph (1), the conservation agriculture intervention enables farmers to generate significant farm and livestock incomes simultaneously, which suggests that the intervention can encourage synergistic outcomes. The treatment households are well spread, with a notable trend towards high livestock and medium agriculture income. Conversely, counterfactual households cluster more to the left, indicating much lower livestock income, and the bottom left corner (low agriculture and low livestock income) is dominated by counterfactual households.

Figure 3: Scatterplots showing Bivariate Trade-Offs that Compare Farming, Livestock and Business Income Streams for Conservation Agriculture and Sustainable Intensification Households. **Please Note:** each dot represents a single survey of a household, and the performance of the household in relation to the two income streams shown in each graph

Conservation Agriculture (red) and Counterfactual (black) Households



Sustainable Intensification (red) and Counterfactual (black) Households

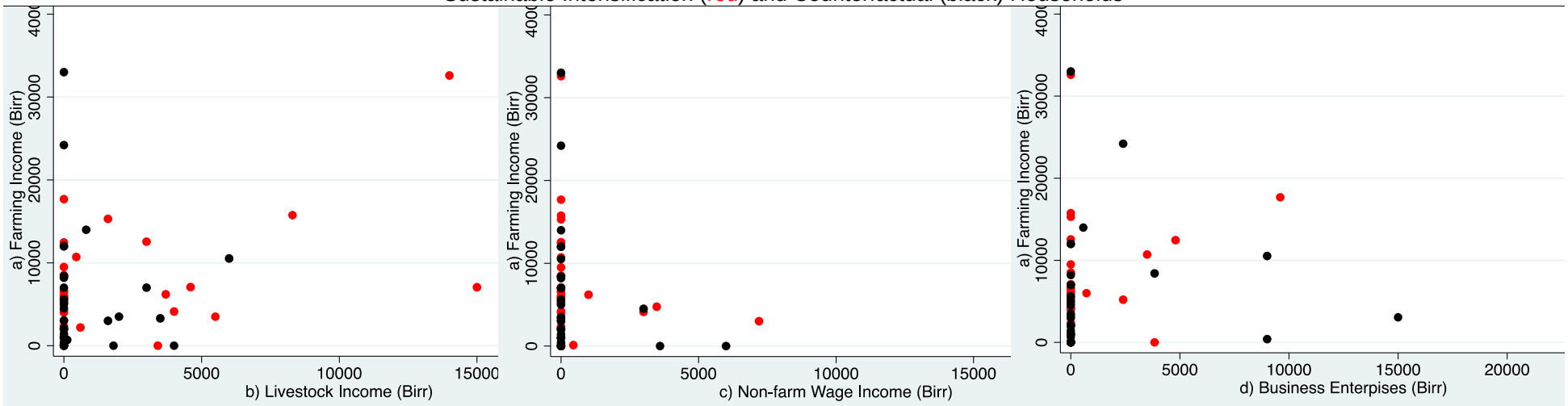
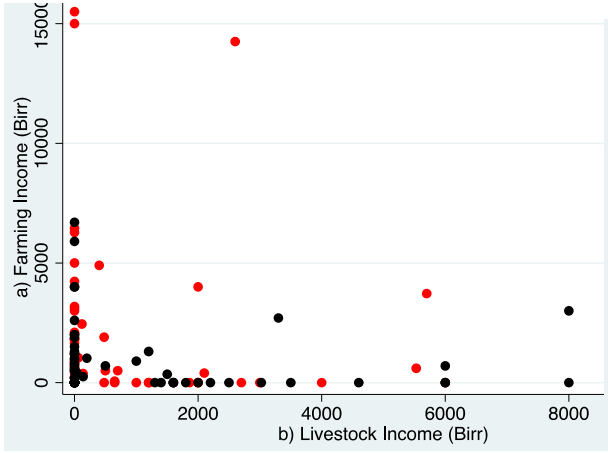
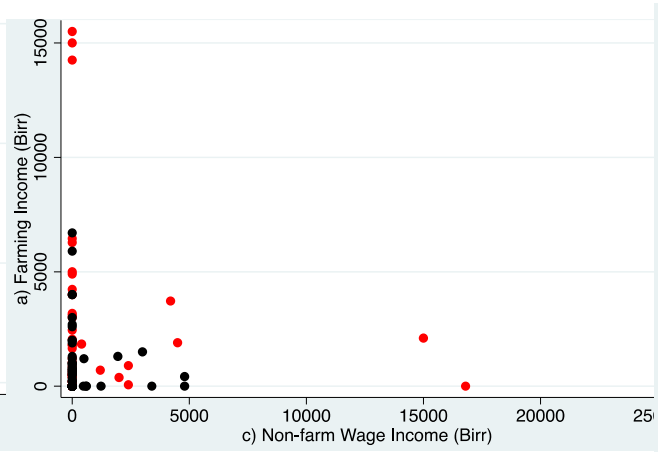


Figure 4: Scatterplots showing Bivariate Trade-Offs that Compare Farming, Livestock and Business Income Streams for SL+PC Households. **Please Note:** each dot represents a single survey of a household, and the performance of the household in relation to the two income streams shown in each graph

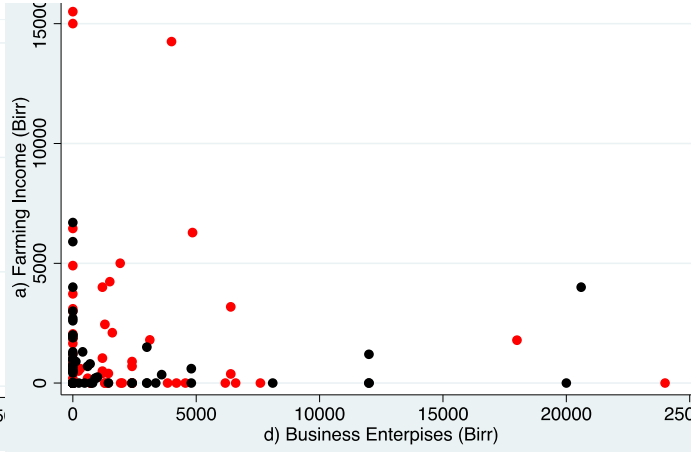
SL+PC (red) and Counterfactual (black) Households



(1)



(2)



(3)

Continuing with the top row of Figure 3, clear trade-offs exist between practicing conservation agriculture and earning off-farm income (2). Aside from one instance, households practicing conservation agriculture don't earn any off-farm income (see clustering on Y axis). Several counterfactual households earn non-farm wage labour, with some generating consistent agricultural income at the same time. While a similar pattern is discernible in relation to income earned through business enterprises (3), but with conservation agriculture households engaging more in these activities. Indeed, some conservation households (7 surveys) report earning more business than agricultural income (see examples along the X axis).

Sustainable Intensification

The bottom row of Figure 3 shows the trade-offs in different income sources for households receiving sustainable intensification interventions, which links mostly strongly to agriculture income streams (1). Once again, sustainable intensification interventions are enabling synergies between agriculture and livestock income, with relatively higher agriculture incomes.

Some sustainable intensification households are managing to earn off-farm income (2). This is in stark contrast to households practising conservation agriculture were such income streams were largely absent, and is more in balance with counterfactual households. Nevertheless, the broader trend is for both household types to just earn agricultural income (see long clustering on Y axis). Conversely, evidence exists that synergies are possible between agriculture and business income, but this is not a broad trend.

SL+PC

The top row of Figure 4 presents income trade-offs of the SL+PC and counterfactual households. In relation to agriculture and livestock income, a starker trade-off relationship often exists when compared to conservation agriculture and sustainable intensification interventions (1). Income data trends suggest close to all households – SL+PC and counterfactual – focus on either agriculture or livestock (see clustering along X and Y axis). This suggests that synergistic production is a challenge on such farms – typically lower income and often female headed. Though there is some indication that SL+PC are taking more livestock related produce to market than counterfactual households (clustering on X axis).

The same tendency to trade-off different income sources exists in relation to business enterprises. Perhaps due to these households often being female headed and relatively poorer, SL+PC households trade-off agriculture and business income streams. However, in instances where synergies are possible, it is almost exclusively SL+PC households that have the ability. Finally, when focusing on off-farm income earned, SL+PC households are engaging in more of such activities relative to counterfactual households, and also relatively more than conservation agriculture and sustainable intensification households.

4. Production

This section focuses on the levels of agricultural production achieved by different intervention households. To develop standardised figures for agricultural production, the monetary value of all harvested crops (market price x weight) are calculated as an indicator of agricultural production.

Conservation Agriculture

The top row of Figure 5 shows the value of production shown as monetary value of all harvested crops for conservation agriculture households and their matched counterfactuals. Households practicing conservation agriculture perform similarly when compared to counterfactual households. The 2nd survey was a particularly strong 6-month period for these households, as they consistently outperformed counterfactual households in relation to the market value of their agricultural produce. On all other years, there is a close correspondence between the 2 groups, but it is clear when observing the other related interventions that it has the lightest effect on production. Please note that conservation agriculture interventions also had a livestock fodder component, the impact of which doesn't register through this indicator.

Sustainable Intensification

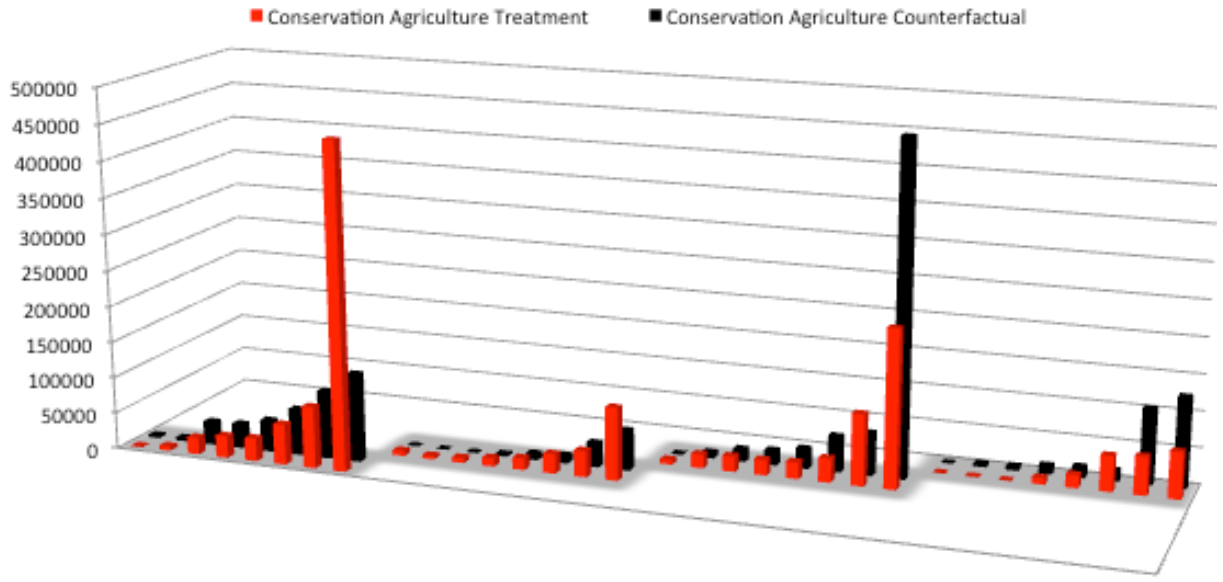
The bottom row of Figure 5 shows the value of production shown as the monetary value of all harvested crops for households receiving sustainable intensification interventions. These households outperformed the counterfactual in all surveys, and surveys 1, 2 and 3, the margins are significantly higher. Only in around 4-5 instances did the counterfactual yield a higher value crop, and some of the highest returns were available to households practicing sustainable intensification. It is also important to compare the scales across the two rows of Figure 5 and Figure 6. Though, the most consistent crop performance came from households practicing sustainable intensification, the highest value harvest in absolute terms came from conservation agriculture households and their counterfactuals.

Irrigated Vegetables

Figure 6 presents the monetary value of crops for households receiving the irrigated vegetable interventions and their counterfactuals (2 surveys only). Irrigated vegetable interventions largely remove the seasonal aspects and this shows in the data. The initial survey shows irrigated vegetable households performing as well, or slightly under, the counterfactual households. Nevertheless, the irrigated vegetable transforms productive capacity in the drier season, and all such households received a crop during the second survey, many of which were of much higher value than the counterfactuals in the rain-fed season. Meanwhile, no counterfactual household managed any crops during this survey.

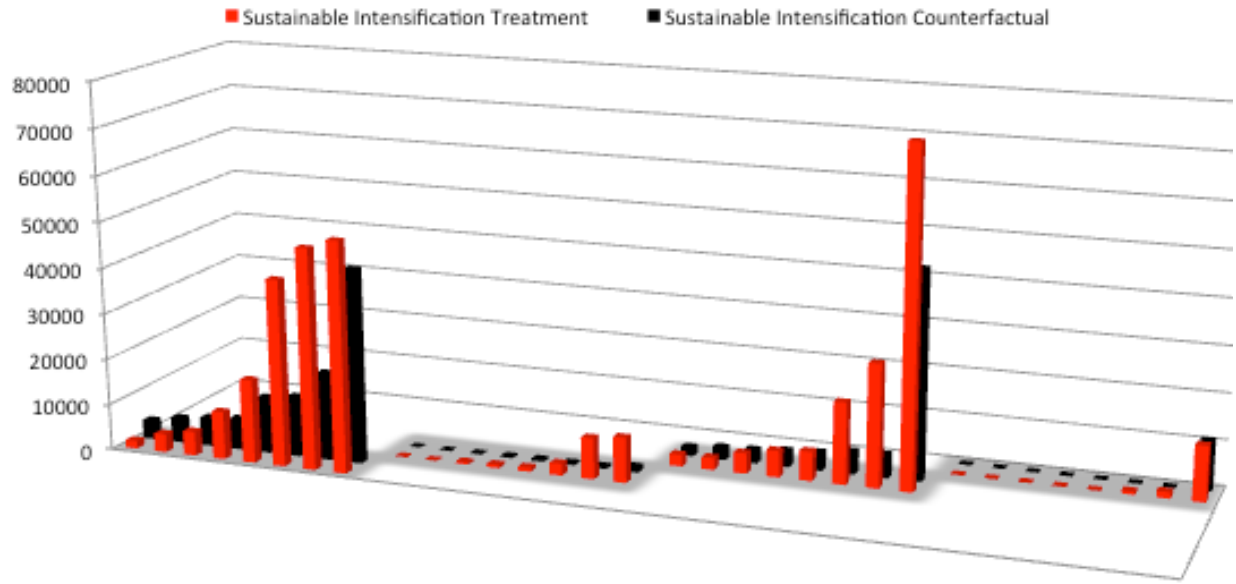
Figure 5: Agricultural Production shown in Monetary Form (Market Value of All Crops Harvested) and in Ascending Order. Sustainable Intensification (bottom) and Conservation Agriculture (top) Households are Compared to Counterfactual Households Across all 4 Surveys

Conservation Agriculture and Counterfactual Households



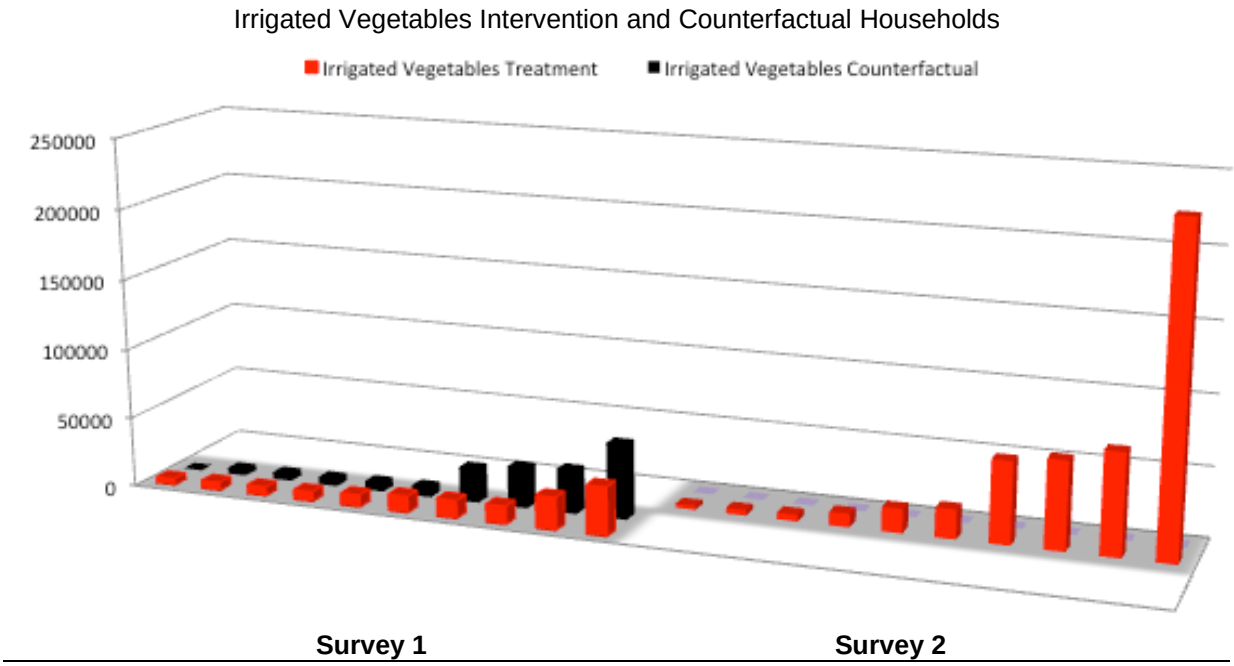
Survey 1 **Survey 2** **Survey 3** **Survey 4**

Sustainable Intensification and Counterfactual Households



Survey 1 **Survey 2** **Survey 3** **Survey 4**

Figure 6: Agricultural Production shown in Monetary Form (Market Value of All Crops Harvested) and in Ascending Order. Irrigated Vegetable Intervention Households are Compared to Counterfactual Households Across the Most Recent 2 Surveys



5. Comparing Connections between Production, Consumption and Income

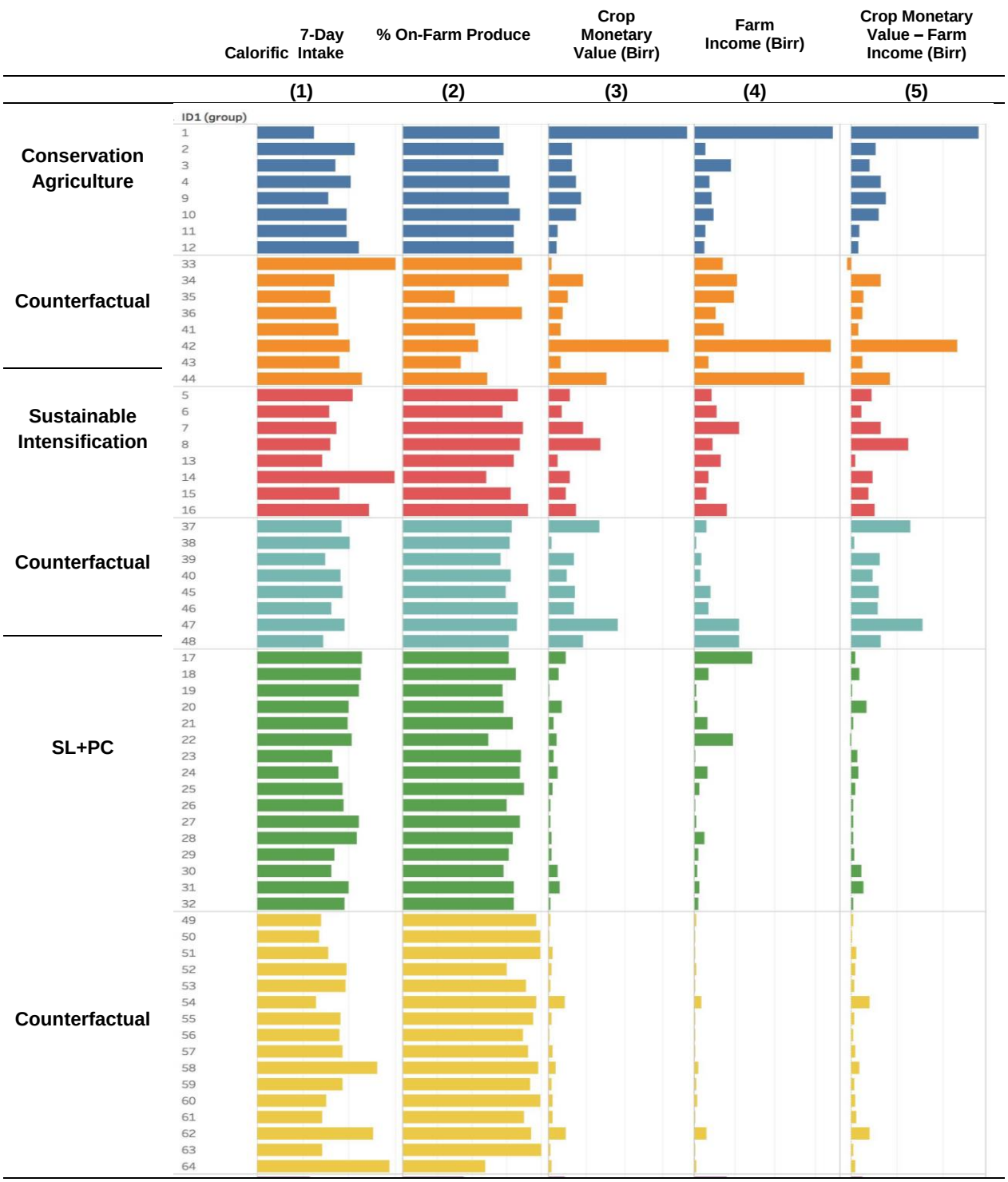
Figure 7 tabulates several indicators of production, consumption and income (aggregating the 4 surveys of each household together), and further, divides the sample up according to intervention types and their respective counterfactuals (irrigated vegetables omitted for purposes of standardisation). From left to right: Column (1) is the total calories consumed in the past 7 days at the point of survey; Column (2) shows the percentage of food consumed in the past 6 months that was produced on the farm; Column (3) is the monetary value of crop production (i.e. the same production data used above); Column (4) is the level of farm income in the previous 6 months; Column (5) is the monetary value of crops minus crop income as an indicator of crops available for consumption.

Relations between indicators can be explained as a series of hypotheses: H_1 - The greater the consumption of on-farm produce, the less crops available for sale in markets; H_2 the higher the calorific intake – assuming high consumption of on-farm production - the less crops available to sell; H_3 the higher the monetary value of crop production, the higher the aggregate level of all other consumption income and crop surplus indicators; H_4 the higher the level of crop income, the lower the level of crop surplus. By disaggregating according to intervention type, and aligning the different indicators, Figure 7 enables a standardised comparison of the different indicators of production and consumption.

In relation to H_1, when comparing all entries for all households, there is a negative overall correlation between (2) percentage of on-farm produce consumed and (4) crop income (correlation coefficient = -0.17). According to Figure 7, this is evident when observing multiple high farm income households, particularly that receive the conservation agriculture and SL+PC interventions, but this trend is perhaps clearer in their counterfactual. Only households

receiving the sustainable intensification interventions were able to demonstrate a positive association between consumption and the sale produce (+0.14), but even this may be because of location effects, because their counterfactual households achieved this same result (+0.14).

Figure 7: Comparing Production, Nutrition, and Income for Sustainable Intensification, Conservation Agriculture and SL+PC Households. All 4 Surveys are Summed for Reasons of Comparison.



In relation to H_3, there is a strong link between (3) crop production and (4) crop income (correlation coefficient = +0.44). When observing trends in Figure 7, there is a close correspondence between crop production and farm income. This trend is close to uniform across intervention types, perhaps with the exception of SL+PC households. The pattern also

fits with the previous negative linkages between consumption and income, which suggests that consumption is compromised when these households channel on-farm produce towards markets. That is, aside from certain conservation agriculture households.

In relation to crop income and crop surplus (crop production value minus farm income), there is a notable trend in intervention households (e.g. sustainable intensification and SL+PC at least) towards a having a neutral or flat relationship (correlation coefficients = 0.00 and +0.05) between farm income and crop surplus. This means that there is little discernible link between taking crops to market, and having a surplus left over, which is intuitive. In Figure 7, the lack of accordance is easily observable from conservation agriculture households. Yet, counterfactual households show strong positive relationships between farm income and crop surplus (correlation coefficient = +0.39, +0.40 and +0.71). This suggests interventions are structuring systematically different farmer-market linkages. Counterfactual households consistently keep produce back and ensure a greater balance between produce kept and produce sold.

Figure 8: Comparing Mean Production, Nutrition, and Income for Sustainable Intensification, Conservation Agriculture, SL+PC and Irrigated Vegetable Households.

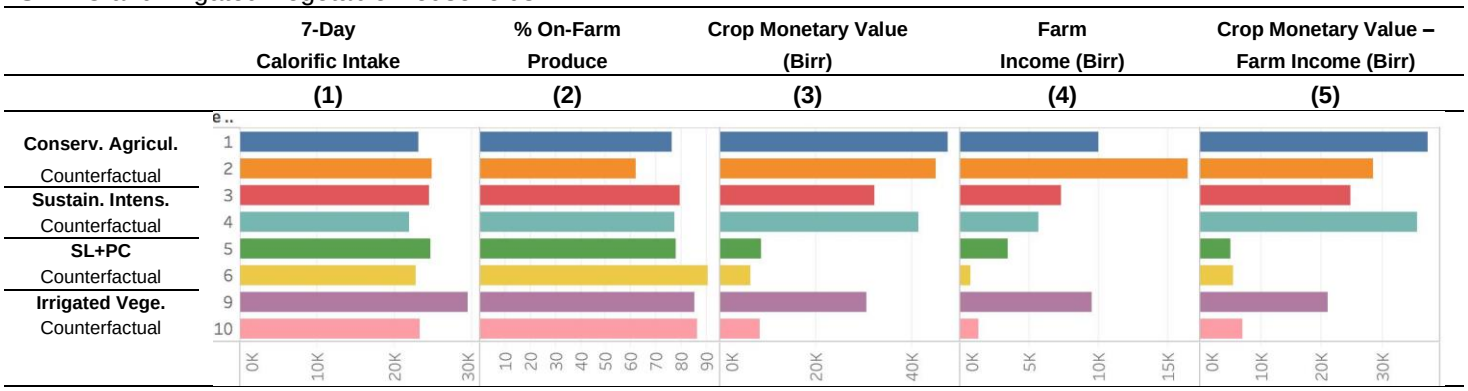


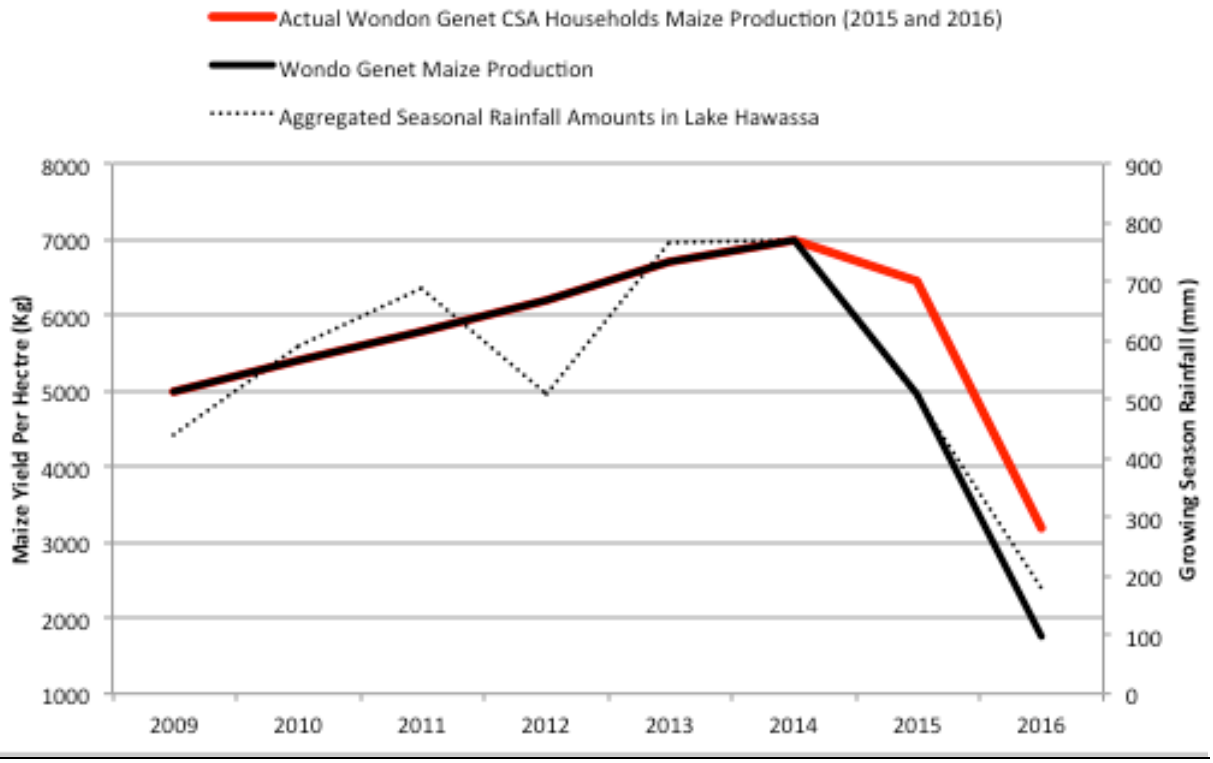
Figure 8 provides the same data presented in Figure 7, but instead takes the mean value across all households and all surveys. This enables us to include irrigated vegetable (which had 2 instead of 4 surveys) households into the comparison of intervention types. The first point to note is that irrigated vegetable households perform best of all intervention types relative to their counterfactual households, and is particularly the case for crop production and farm income. They do manage a positive relationship between farm income and consumption of on-farm produce/calorific intake, as well as the positive association between crop production, farming income and crop surplus.

6. Measuring Climate Resilient Crop Production: Expected v Actual Maize Yields

Direct measurements of resilience are beginning to directly assess that the severity of shock/stresses (Collins, 2012), and move away from assumptions in indices and proxy indicators (Prasher et al., 2012; Fuller and Lain, 2015). But recent studies have focused on the general resilience of households, rather than contextualising outcome indicators to specific shocks (Bene et al, 2017). This section presents a method to directly measure climate resilience that doesn't use assumptions around the drivers/characteristics, or a generic approaches to resilience, through observing the yield of drought resistant maize varieties under varying levels

of climate stress. The analysis integrates data on maize yield and meteorological data to the relationship between of maize production and climate hazards (meaning, what aspects of climate variability constitute a shock or stress on crops). Once the relationship is established, the finding can be used to estimate 'expected' levels of productivity given a certain level of climate stress, versus 'actual' levels of maize production.

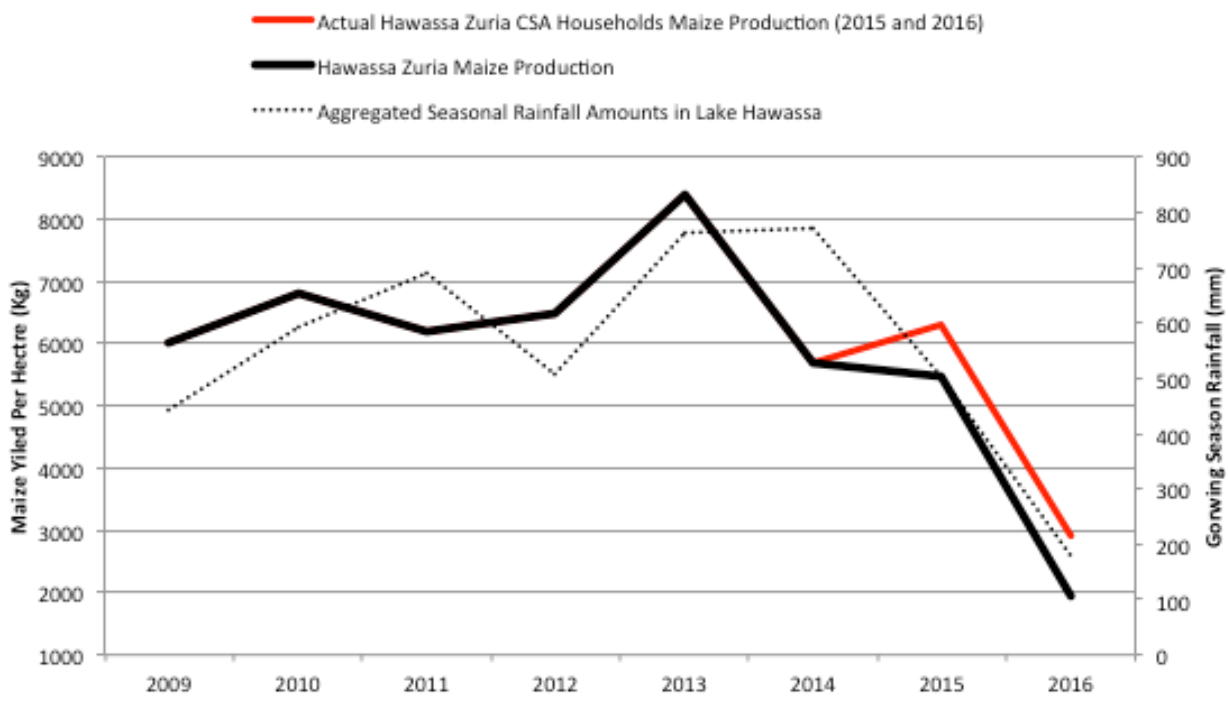
Figure 9: Comparing Expected and Actual Maize Crop Production Yields in Wondo Genet for Sustainable Intensification Households in Receipt of Improved Seed Varieties



Data Sources: Hawassa Survey; Hawssa Met. Dept.; Hawassa Office of Ministry of Agri. and Nat. Resources

Figure 9 illustrates the comparison of expected and actual maize crop production for households in receipt of improved seed varieties in Wondo Genet. Various hazards are explored – e.g. number of consecutive days, late/early season onset/offset – to establish the most appropriate relationship between rainfall and maize crop production over the past five years. In Wondo Genet, the calculation of rainfall level (mm) over the growing season (June to September) and maize crop production shows a strong relationship (correlation = 0.78). Findings were used to calculate the expected maize yield based on this past relationship between rainfall and production (4,954 kg per hectare in 2015 and 1,756 kg per hectare in 2016) and the actual level within households in receipt of improved seed varieties over that same time period [6,449 kg per hectare in 2015 and 3,188 kg per hectre in 2016]. The difference between the two – 1,495 kg per hectare (+30%) in 2015 and 1,432 kg per hectare (+81%) in 2016 – represent the direct value of climate resilience.

Figure 10: Comparing Expected and Actual Mazie Crop Production Yields in Hawassa Zuria for Sustainable Intensification Households in Receipt of Improved Seed Varieties



Data Sources: Hawassa Survey; Hawssa Met. Dept.; Hawassa Office of Ministry of Agri. and Nat. Resources

Figure 10 shows a further comparison of the expected and actual maize crop production from Hawassa Zuria. The calculation of rainfall level (mm) and maize crop production shows a clear relationship (correlation = 0.31). Findings were used to calculate the expected maize yield based on this past relationship (5,489 kg per hectare in 2015 and 1,945 kg per hectare in 2016) and the actual level within households in receipt of improved seed varieties (6,322 kg per hectare in 2015 and 2,908 kg per hectare in 2016). The difference between the two – 833 kg per hectare (+15.1%) in 2015 and 963 kg per hectare (49.5%) in 2016 – once again represents the direct value of climate resilience.

8. Challenge and Limitations

In the past year, the challenge has been to move beyond basic performance, and bring together different components of the analysis. This enables a lateral livelihoods perspective of the different components of the CSA intervention. So far, the analysis has focused on different income streams, through a trade-off analysis (see Section 3), but the holistic analysis will require greater exploration perhaps based on guidance from Irish Aid and SOS Sahel. In addition, the survey has overcome the issue of low numbers and the control for all intervention types. This latest round of survey findings has been taken from data that matched the different interventions and counterfactual households. Finally, the on-going challenge of data collection around the irrigated vegetables intervention has now be partially overcome by the complete of 2 usable surveys. Having 2 completed surveys enables some analysis, but comparability with other interventions is not always possible. For instance, the entries of different indicators cannot be summed to together because we would be comparing 2 rounds of surveys with 4, so

comparability of irrigated vegetables is restricted analysis of means and trend lines and other similar methods.

In relation to the natural resource regeneration study, there are two challenges worth documenting. First, the project site selected for natural resources related activities in Hawassa Zuria woreda were adjacent to some similar projects implemented by other organization. This made it difficult to distinguish SOS Sahel intervention sites from others when the intervention site analyzed using remote sensing imagery. Second, data management for all intervention sites was poor, which made it a challenge to access information relating to specific intervention types, its respective area of coverage in each kebeles, and to specify when the intervention started.

Recommendations

1. The findings from the data indicate that households practicing the sustainable intensification technology consistently perform well relative to counterfactual households in terms of production, income and nutrition. This is shown here through both absolute and relative measures of the core outcomes of the intervention. There is evidence the intervention steadily intensifies agricultural and livestock production, income, while balancing demands with on-farm consumption. Though perhaps the greatest achievement has been to improve the climate resilience of maize farmers, enabling them to endure a significant rainfall shock in 2016. Lessons relating to inputs and training should be taken from the implementation of this intervention, and there is now emerging evidence that justifies the expansion of intervention coverage, which will enable larger numbers of households to intensify agricultural livelihood and build climate resilience.

2. Conservation agriculture households are assessed as not performing well, now that the counterfactuals are more robust. Many counterfactual households function better in relation to agricultural production and income generation, as well as alternative livelihoods. This may be due to the longer learning process of conservation agriculture, but there is a need to identify factors inhibiting production and income.

3. SL+PC households perform marginally better than counterfactual household in relation to livestock and agricultural income. In addition, evidence is emerging that such households can diversify livelihoods easier, which suggests more synergies between farm and off-farm livelihood activities. SL+PC interventions are enabling some agricultural and livestock production, while maintaining diversified livelihoods. Overall, the intervention is performing well considering that such households are the poorest with minimal assets to endure shocks.

4. Irrigated vegetable households are able to practically circumnavigate drought and other aspects of climate variability and households produce crops in the dry season. They are performing as well in the rainy season as their counterfactual households, but are able to produce two crops per year due to their new technology. In addition, their record in relation to the linkages between production, consumption and income is also respectable, which shows that the intervention is contributing well to the core Irish Aid objectives. Further investigation is required to establish the effect on local vegetable markets to ascertain the sustainability of the practice.

Workplan and Budget (2015-2018)

The methodology was designed and finalised by Echnoserve and IIED in the final quarter of 2015. In terms of Track 1, baseline data was collected on institutional climate risk management and coordination in the second quarter of 2016. The findings were presented in the annual report of 2016. For Track 2, IIED and Echnoserve have now completed 4 rounds of data collection over 2 years, and results have been circulated on an on-going basis including this annual report. The same data will be collected on 2 more occasions in both November 2017 and June 2018. A final report will be provided, with a stand alone section on the gender dimensions of the interventions.

The additional components are also emerging. The mapping of natural resources component will began in the third quarter of 2016, which is contextualised using focus group discussions for linkages between natural resource regeneration and livelihood outcomes (Track 2). A full report of this exercise has been submitted at the same time as this report. A 2nd round of data collection will be completed in late 2017 to establish progress relative to the baseline.

References

Béné, C., Chowdhury, F. S., Rashid, M., Dhali, S. A., & Jahan, F. 2017. Squaring the Circle: Reconciling the Need for Rigor with the Reality on the Ground in Resilience Impact Assessment." *World Development* 97, pp. 212-231.

Brooks, N., Anderson, S., Burton, I., Fisher, S., Rai, N., & Tellam, I. 2013. An operational framework for Tracking Adaptation and Measuring Development (TAMD). *IIED Climate Change Group Working Paper*. pp. 1-40.

Collins, G. 2012. Resilience in USAID. USAID Concept Note, 1-4.

Fuller, R. and Lain, J. (2015) *Measuring resilience: Lessons learned from measuring resilience in Oxfam's large-N effectiveness reviews.* Discussion Paper, December. Oxford: Oxfam.

Irish Aid Led Consortium Partners. 2014. Improving smallholder livelihoods and resilience in the SNNPR through climate smart agricultural economic development. Irish Aid Project Proposal. pp. 1-64.