Exploring projected outcomes of the FoodSECuRE Small Grains project

Evidence from Zimbabwe

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EXPLORING PROJECTED OUTCOMES OF THE FoodSECuRE SMALL GRAINS PROJECT: EVIDENCE FROM ZIMBABWE

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CONTENTS

INDEX OF TABLES

INDEX OF FIGURES

INDEX OF MAPS

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The views in this report and any errors or omissions are those of the author.

Acronyms

ALPS	Alert for Price Spikes indicator
CARI	Comprehensive Approach for Reporting Indicators
CPI	Consumer Price Index
EST	Trade and Markets Division of FAO
FAO	Food and Agriculture Organization
FCS	Food Consumption Score
FOODSECURE	Food Security Climate and Resilience
LAIDS	Linearized Almost Ideal Demand System
LES	Linear Expenditure System
MDER	Minimum Daily Energy Requirement
SARCOF	Southern Africa Regional Climate Outlook Forum
SISMOD	Shock Impact Simulation Model
VAM	Vulnerability Analysis and Mapping Unit of WFP
WFP	World Food Programme
WRSI	Water Requirement Satisfaction Index

EXECUTIVE SUMMARY

Between 2014 and 2016, El Niño weather patterns brought drought to south-eastern regions of Africa, slashing the production of staple cereals for the 2015/16 agricultural season. Zimbabwe was no exception. Following the drought, food security has deteriorated for 1.3 million people in the country, bringing the number of food insecure up to 2.8 million.[1]

An analysis of project results led by the Food Security Climate and Resilience (FoodSECuRE) unit highlights the crisis situation of poor agricultural communities in Zimbabwe. Although food assistance is allowing these communities to achieve basic levels of food security, outcomes vary greatly. Households with fewer productive tools are finding it more difficult to be food secure; there are also big differences according to geographical area, level of expenditures, level of production, and gender of household head.

Simulations of the impact of El Niño with and without FoodSECuRE activities reveal the following insights:

1. Current price changes have not (yet) had a significant impact on household food security.
2. The drop in production caused by the drought affected all surveyed households negatively, although households headed by women became more vulnerable than those headed by men.
3. FoodSECuRE activities led to 11 percent more agricultural production value (in US$) compared to the counterfactual scenario.
4. As expected, data show that providing assets and irrigation is crucial for a higher yield.
5. Households with larger irrigated plots are still investing in the production of maize and are achieving higher yields.
6. In the 2015/16 season, pearl millet was the most cultivated crop and finger millet the most productive. The larger the area with the same crop, the lower the yield.
7. For the population benefiting from FoodSECuRE, food insecurity increased less than the national average: it rose 32 percent in the province compared with a national increase of 86 percent between November 2015 and March 2016.

[1] Estimates by the Food Security and Nutrition Working Group, February 2016, available at http://documents.wfp.org/stellent/groups/public/documents/ena/wfp284279.pdf

1. INTRODUCTION

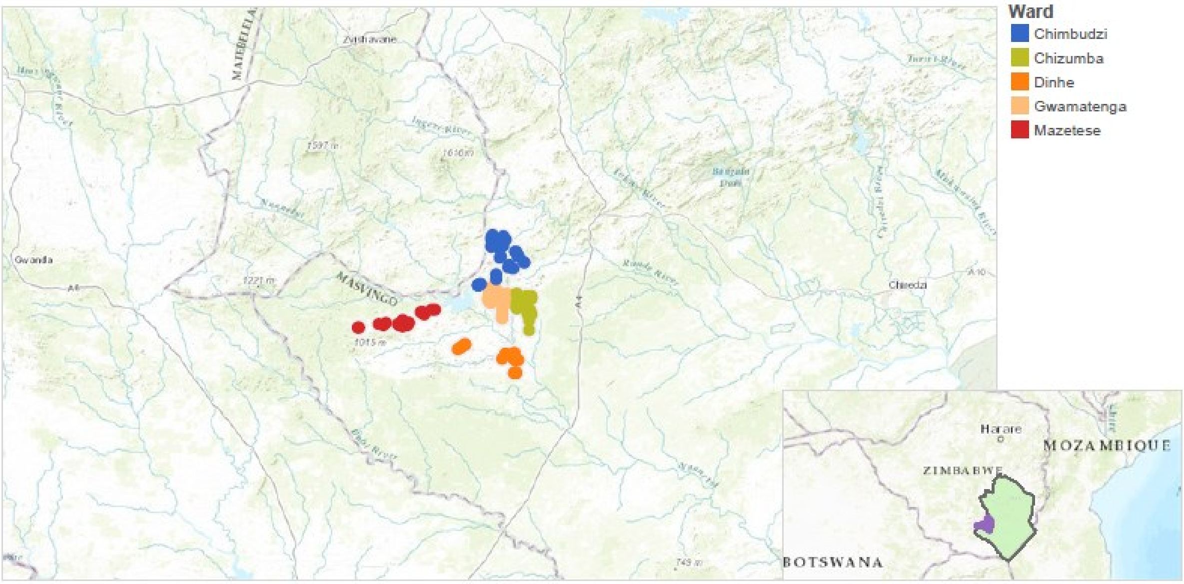
In 2014/16, El Niño caused severe spells of drought in many countries in Africa, including in Zimbabwe, where both agricultural production and food prices were affected.

The shock was largely anticipated by a number of institutions, such as the Southern Africa Regional Climate Outlook Forecast (SARCOF), the Zimbabwe Meteorological Department and the WFP Vulnerability Analysis and Mapping unit (VAM). WFP has developed a number of early warning mechanisms that use climate forecasts. In particular, the Food Security Climate Resilience Facility (FoodSECuRE) aims to trigger early community-level action before a climate shock occurs.

In the two-year period 2015–16, WFP field-tested the FoodSECuRE mechanism in Zimbabwe to assist communities likely to be affected by below-average rainfall, promoting drought-tolerant small grain cultivations including sorghum and millet seed varieties.[2] These grains used to be produced and consumed in drought-prone communal areas in Zimbabwe, but since the introduction of maize around 100 years ago they have been neglected as smallholders have focused their farming activities on maize.

In November 2015, under the aegis of the FoodSECuRE initiative, the 'Small Grains' project launched a household questionnaire designed to draw a baseline of the households involved in farming activities in five wards[3] of Mwenezi district, located in the region of Masvingo in the south of the country. Map 1 shows where the 374 sampled households live.

Map 1: Sampled villages per ward



Source: Author's mapping

[2] Zimbabwe WFP Monitoring and Evaluation Update #9: 8 December 2016.

[3] The districts of Zimbabwe are divided into 1,200 municipal wards, corresponding to the third administrative level.

In addition to the baseline, we modelled the impact of price and production shocks on rural households to estimate how food security was affected in Mwenezi district via income and consumption transmission mechanisms, using a Light Shock Impact Simulation Model (SISMod-Light[4]) developed jointly by WFP and FAO.[5] The simulated data was then compared against the baseline.

This report comprises four sections. The next section presents the methodology used to produce the estimates and details the assumptions made to replicate the current situation. Section 3 discusses the results in terms of agricultural income, expenditures, gender of household head and dependency ratio by ward. The final section contains our concluding remarks.

2. Methodology

This model aims to replicate the economic behaviour of households in the event of a shock. A production shock similar to the El Niño event can be modelled in economic terms according to a specific shock impact factor, which we define as the cereal production outcomes ratio between the baseline and the simulated period, and similar ratios between food price and inflation levels. Modelling the specific shocks requires some assumptions, which we explain in more detail below. The economic behaviour of each household is modelled through a Linear Expenditure System (LES) and a Linearized Almost Ideal Demand System (LAIDS). We input the following data:

- Demographics;
- Expenditures on food and non-food items;
- Days in which any food item from different groups has been consumed by household members over a seven-day recall period;
- Agricultural inputs;
- Land utilization and crop production; and
- Other agricultural-related information and project-related information.

Using a LES[6] with these data, we built a matrix of coefficients – i.e. income elasticities for expenditures – that expresses how the allocation of disposable income to food and non-food items changes.

[4] This paper uses a light version of SISMod to overcome the limitation of missing quantities consumed. For more information on the full version of SISMod, please see Fang, Cheng, Sanogo, Issa, 2014, *Food price volatility and natural hazards in Pakistan* FAO/WFP. http://www.fao.org/documents/card/en/c/9bbe0876-770b-4c97-8b52-c296ee94207d/

[5] At-a-glance information about SISMod is available here. For further details, visit http://faowfpmodel.wix.com/sismod or write to *wfp.economicanalysis@wfp.org*

[6] Singh, Inderjit; Squire, Lyn; Strauss, John [editors]. 1986. *Agricultural household models : extensions, applications, and policy*. Baltimore, MD: The Johns Hopkins University Press.

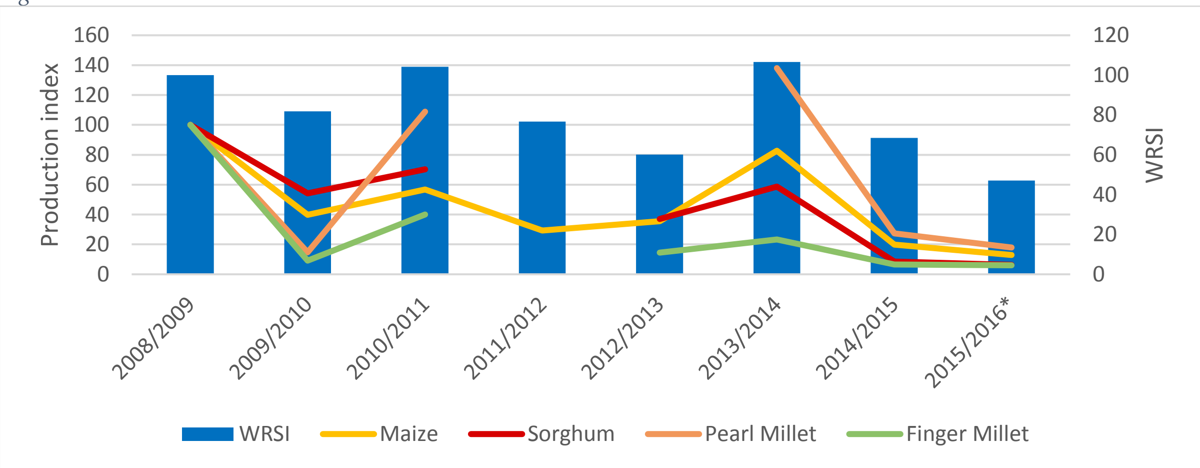
The changes affect household food expenditures through a LAIDS[7] – i.e. demand elasticities – which then influence household food consumption.

The shocks are modelled as follows: we assume that a drop in income[8] from lower agricultural production has a linear effect on expenditures. Since household food expenditures (but not quantities) are commonly available in surveys, we derive the quantities by linking these expenditure shares to human food consumption as described in FAO's Food Balance Sheet and expressed in terms of daily caloric consumption per person for each item (group).[9] The final step is to transform these estimated food quantities into food security outcomes by transforming consumption shares into grams using NutVal data.[10] We assume that the sampled households with acceptable food consumption[11] have a consumption pattern in line with what is described in the Food Balance Sheet. Thanks to these assumptions we are able to obtain a proxy for quantities consumed in each food group and compare it with the actual expenditures.

Shocks

Figure 1 shows the drop in yields that occurred in the 2015/16 season as revealed by a trend analysis of rainfall and production data.[12]

Figure 1: Production index and WRSI



Source: Author's calculation using WFP/VAM estimates and Ministry of Agriculture data. Base year 2008/09

The agricultural production recorded in the growing season 2015/16 was the lowest since 2008/09 and followed another negative harvest in the previous season, although conditions

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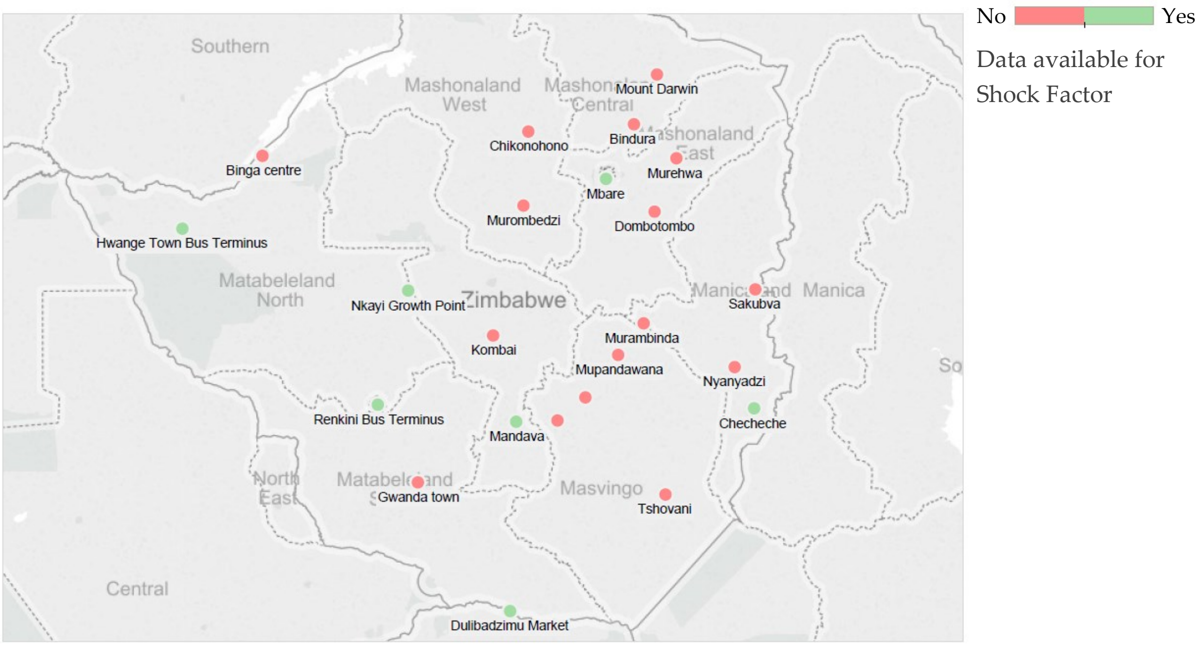
[7] Angus Deaton and John Muellbauer, 1980. "An Almost Ideal Demand System" in *American Economic Review*, 1980, vol. 70, issue 3, 312–26.
[8] Normally income is unknown and is deduced from household expenditures; if it were asked for directly, households would likely underestimate it.
[9] FAOSTAT – Food Balances: http://faostat3.fao.org/home/E
[10] We used the NutVal 4.0 edition: http://www.nutval.net/
[11] In this section, we refer to acceptable food consumption when the Food Consumption Score is equal to 38, the threshold level for Zimbabwe.
[12] Source: Zimbabwe Ministry of Agriculture.

were favourable in the 2013/14 season. For the remainder of this paper, we will refer to this drop in yields as the "production shock".

The change in production resulting from different yields is the outcome of farmers' decisions regarding cultivation techniques and land utilization (e.g. area planted), and the agro-climatic conditions – the accumulated rainfall – which we consider in order to build the crop water requirement satisfaction index (WRSI).

The second shock is price volatility, captured by a) the Consumer Price Index (CPI)[13] – an indicator that expresses the changes over time of the price of a basket of goods and services; and b) retail food prices.[14] In Map 2, the markets in green are those for which we have data both for the baseline month (November 2015) and for the month preceding the simulation (March 2016).

Map 2: Markets sampled in the VAM portal



Source: Author's elaboration

Since price levels were similar among the markets in Masvingo province, we averaged the prices of Renkini Bus Terminus, Mandava, Dulibadzimu and Checheche markets as a proxy of the prices in the district. The foods monitored in those markets are maize, millet, sorghum, wheat, beans, cowpeas and vegetable oil. The change reported in Table 1 refers to the average nominal price difference between November 2015 and March 2016, while the average price is the one as at March 2016.

[13] Reserve Bank of Zimbabwe : http://www.rbz.co.zw/
[14] VAM Shop: http://vam.wfp.org/CountryPage_indicators.aspx?iso3=ZWE

Table 1: Nominal price change from Nov. 2015 and average nominal price in Mar. 2016

	Beans	Cowpeas	Groundnuts	Vegetable oil	Sorghum	Wheat	Maize meal	Maize	Millet
Change	0%	0%	0%	-1%	12%	0%	6%	8%	0%
Average Price (US$/kg)	1.74	0.7	1.02	1.76	0.55	0.52	0.63	0.48	0.34

Source: Author's calculation

Table 2 shows real price[15] changes occurred for staple commodities – including wheat, maize, sorghum and millet – between November 2015 and March 2016. This is the result of the expected drop in production of the cereal crops.

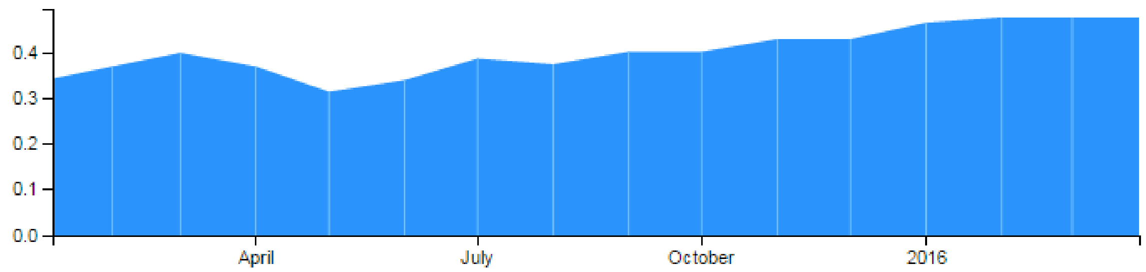
Table 2: Shocks of CPI and food prices in real terms, Mar. 2016 to Nov. 2015

CPI		Real Prices				
Food	Non-Food	Staple	Pulses	Animal Proteins	Vegetables and Fruits	Other
-0.20%	-0.50%	5.60%	0.50%	0.50%	0.30%	-0.50%

Source: Author's calculation

The price trend in Figure 2 follows a seasonal pattern with no major price spikes. Even though the drought may have caused a delay in seasonal price decreases (normally seen in April and May), before running the simulation (i.e. March 2016) it was unclear whether such a decrease would occur or not.

Figure 2: National average of wheat price (US$/kg), Jan. 2015 to Mar. 2016

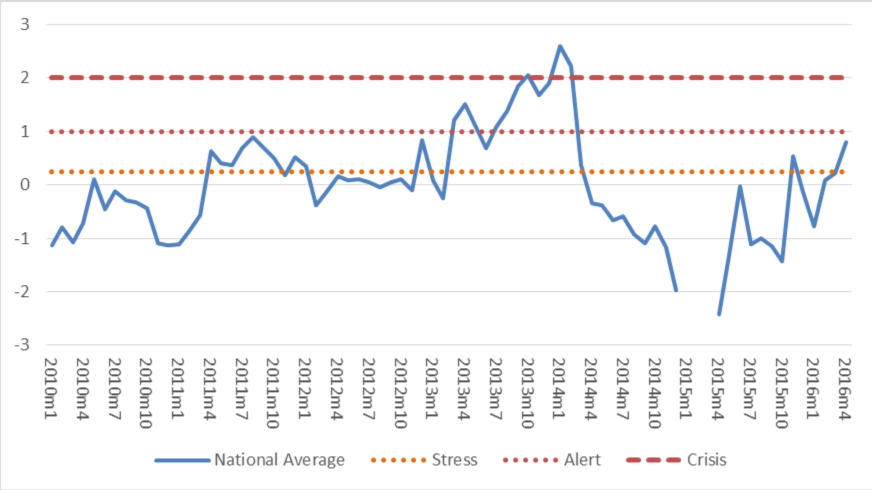


Source: VAM Price database; nationally sampled markets only

In confirmation of this, the Alert for Price Spikes indicator (ALPS)[16] for average maize prices signalled a situation of *Stress* in March 2016, although levels were yet not alarming, as shown in Figure 3. Even so, the indicator is expected to fall following the seasonality of prices in the next few months.

[15] The monthly average of nominal prices was deflated by the monthly value of non-food CPI.
[16] ALPS documentation can be found in the VAM portal at: http://foodprices.vam.wfp.org/alps.aspx

Figure 3: ALPS for national average maize prices



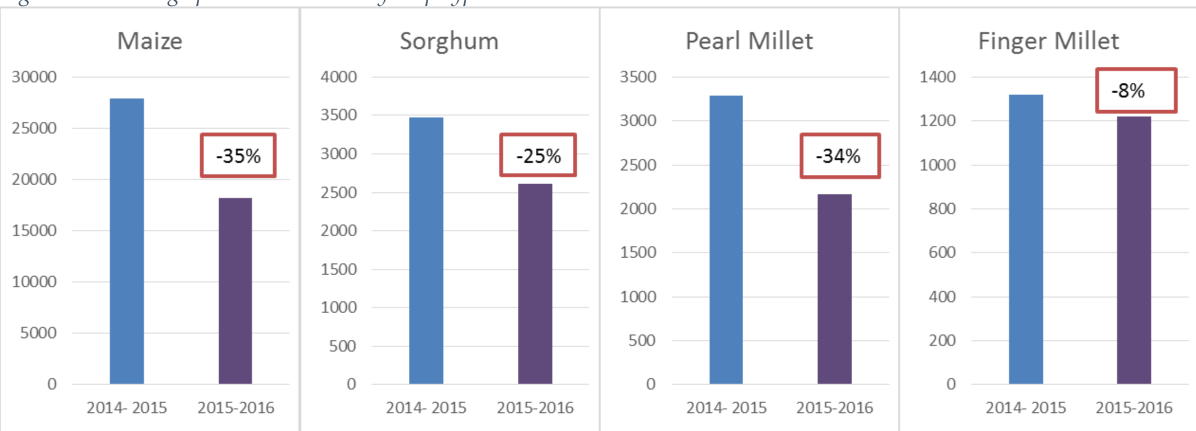
Source: Author's calculation based on VAM price database; Stress, Alert *and* Crisis *levels*

This suggests that the food market in Zimbabwe is more stable than that of other countries in the region, in particular Malawi, Zambia and Mozambique, where most of the sampled markets show cereal prices above normal values.[17]

The estimated production shock has been applied to all household production figures; in this way it is assumed that the shock will take into account the loss in yield of the main crops (maize, sorghum, pearl millet and finger millet) caused by insufficient rains during the growing season.

Figure 4 shows this drop applied to the production of the entire Masvingo region, comparing 2014/15 and 2015/16 growing seasons.

Figure 4: Masvingo production shock by crop type



Source: Author's calculation, VAM estimates, Ministry of Agriculture. Production figures are in metric tons

We assume a comparison scenario in which the entire area had been planted only with maize, i.e. with no distribution of small grains seed (sorghum, pearl millet and finger millet). The objective is to simulate a control group in the absence of the FoodSECuRE project. Maize cultivation covers two thirds of the planted area in Masvingo, even though the yield is similar

[17] Issue 31 of VAM *Market Monitor*, First Quarter 2016, available at: http://documents.wfp.org/stellent/groups/public/documents/ena/wfp283007.pdf

to that of the small grains in the region. Maize has only returned significantly higher yields at the end of the season during very favourable years; in dry years the other grains have proven to be competitive or better performing.

The shock factors were only applied to the yields of maize multiplied by the planted area, thereby obtaining an estimate of production. Wherever households did not plant maize, we obtained a similar indicator[18] by multiplying the other crop yields by the median maize yield.

3. RUNNING THE SIMULATION

In this section, we discuss the results of the simulation using SISMod, based on the methodology and background information described in Section 2. We simulate the impact on household food security using two distinct scenarios:

Scenario 1) Production of small grains and maize with a drop in yields as per Figure 4, prices of March 2016, causing the shock illustrated in Table 2.

Scenario 2) Production of maize only with a drop in yields as per Figure 4, prices of March 2016, causing the shock illustrated in Table 2.

First we present the results with the CARI console,[19] and then we break them down by population subgroups.

Besides income scenarios, the following sections disaggregate the results in different groups. Specific agricultural income is observed by quartiles. We analyse the different expenditures, looking at different wards of residence as well as demographic characteristics such as the gender of the household head and dependency rate quartiles.

The average quantity produced under scenario 1 (Table 3) is higher in all wards where the FoodSECuRE project has been implemented. By contrast, overall production under scenario 2 is lower, potentially because maize production suffers from lack of water.

[18] The household average of the ratios of the yields of each crop over the median yield of each crop. We assume that the yield is a result of household and land dotation specificities; this attempts to reflect those specificities with the different median yield of maize.

[19] We do not simulate categories for the livelihood coping strategy index with SISMod: the available data did not allow the behavioural modelling necessary for such an estimation.

Table 3: Production estimates (kg) in the two simulations

	Baseline						Scenario 1						Scenario 2		
	Maize	Sorghum	P. Millet	F. Millet	**Total**	**Maize share**	Maize	Sorghum	P. Millet	F. Millet	**Total**	**Maize share**	Maize	**Total**	**Maize share**
Chimbudzi	37	54	97	30	**219**	*17%*	24	41	64	28	**157**	*15%*	146	**146**	*100%*
Gwamatenga	65	69	215	11	**361**	*18%*	43	52	142	10	**247**	*17%*	123	**123**	*100%*
Chizumba	23	53	150	1	**228**	*10%*	15	40	99	1	**155**	*10%*	111	**111**	*100%*
Dinhe	11	38	125	1	**175**	*6%*	7	28	82	1	**119**	*6%*	107	**107**	*100%*
Mazetese	41	54	88	0	**182**	*22%*	27	40	58	0	**124**	*21%*	115	**115**	*100%*
Total	177	268	675	44	**1165**	*15%*	116	202	445	41	**803**	*14%*	601.2	**601**	*100%*
Share of total	*15%*	*23%*	*58%*	*4%*			*14%*	*25%*	*55%*	*5%*			*100%*		

Source: FoodSECure survey, November 2015. Author's calculation based on SISMod simulation

Income scenarios

We multiplied the quantities produced by market prices to estimate the average income that each household could receive if they sold their produce in the marketplace. Maize production in the baseline year (Table 4) represents between 7 and 24 percent of the overall earnings[20] from agricultural cultivation of those households.

The most productive ward is Gwamatenga, where maize production contributes 20 percent of the total monetary value of production, and all the crops have higher yields compared to the other wards, particularly pearl millet. **Finger millet is the most neglected** crop, except in Chimbudzi, where it represents 12 percent of the value of production **although its yield**, an estimated 130 kg per hectare, **is higher than other crops and this crop seems to be more resistant to dryness as its yield fell just 8 percent during the drought period**.

[20] Including the share of the crop that is later consumed by the household.

Table 4: Estimated income in US$

	Baseline						Scenario 1						Scenario 2		
	Maize	Sorghum	P. Millet	F. Millet	**Total**	**Maize share**	Maize	Sorghum	P. Millet	F. Millet	**Total**	**Maize share**	Maize	**Total**	**Maize share**
Chimbudzi	16	25	33	10	**84**	*19%*	10	19	22	10	**61**	*16%*	63	**63**	*100%*
Gwamatenga	28	32	73	4	**137**	*20%*	18	24	48	3	**93**	*19%*	53	**53**	*100%*
Chizumba	10	25	51	0	**86**	*12%*	7	18	34	0	**59**	*12%*	48	**48**	*100%*
Dinhe	5	17	43	0	**65**	*8%*	3	13	28	0	**44**	*7%*	46	**46**	*100%*
Mazetese	17	25	30	0	**72**	*24%*	11	18	20	0	**49**	*22%*	49	**49**	*100%*
Total	76	124	230	14	**444**	*17%*	49	92	152	13	**306**	*16%*	259	**259**	*100%*
Share of total	*17%*	*28%*	*52%*	*3%*			*16%*	*30%*	*50%*	*4%*			*100%*		

Source: FoodSECure survey, November 2015. Author's calculation

Overall, households in all the wards under scenario 1 have lower estimated income. Although farmers in Gwamatenga have still the highest shares, the value of production is estimated to drop by 32 percent compared to baseline data (Table 4). Chimbudzi ward performs slightly better, as the relatively higher concentration of finger millet and sorghum limits the fall in value to 27 percent.

The agricultural income of farming households in scenario 1 would break down as follows: pearl millet (50 percent), sorghum (30 percent), maize (16 percent) and finger millet (4 percent). Average income is US$62 per season, corresponding to US$1.24 a week. With prices close to those recorded in March 2016, the value of a balanced food basket would be around US$2.25 a week, meaning that agricultural production would barely cover half of the needs (55 percent). The rest of the expenditure needs would either be covered from other income sources[21] or remain unmet.

If households were to rely solely on maize production as per scenario 2, the yields would be even lower, with an average income from cropping agriculture 11 percent lower than in scenario 1 (US$51 or US$1.10 a week).

Estimated income is similar in both scenarios only in Chimbudzim Dinhe and Mazatese. By contrast, households in some wards would face a considerable fall in their average income if they only grew maize: income in Gwamatenga would be 30 percentage points less and income in Chizumba would be 14 percentage points less than in scenario 1.

Food security scenarios

Following the above-mentioned assumptions used to estimate the quantities consumed, we determined the cost of a reduced food basket composed of maize, sorghum, wheat, millet, pulses and oil using March 2016 prices. The monetary value of US$1.51 is per week per capita,

[21] Information on these other income sources was not available in the baseline questionnaire.

while the reduced food basket covers 67 percent of the daily caloric intake. As such, the estimated cost of 2,100 kcal food basket would be roughly US$2.25 (Table 5).

Table 5: National food basket composition, prices, consumption and expenditures

	Price per kg (US$)	Kcal per person per day	Daily consumption (grams)	Weekly expenditures (USD)
Maize	0.43	743	153	0.46
Sorghum	0.46	44	13	0.04
Wheat	0.49	243	74	0.25
Millet	0.34	31	8	0.02
Pulses	0.70	45	45	0.22
Oil	1.84	301	40	0.51
Total		***1406***	***333***	***1.51***
Share of 2100 kcal per person per day			If 2100 kcal covered	
	67%			2.25

Source: Author's calculation

The average per capita expenditure for the FoodSECuRE sampled households was US$1.98 – lower than the national average of US$2.15. One possible explanation for this is consumption from own production, which occurs when the selling price is not attractive for the household, pushing it into autarky[22] given its own shadow price.[23] Alternatively, households might simply be consuming less food.

We used the Comprehensive Approach for Reporting Indicators of Food Security (CARI)[24] to compare the food security situation of the sampled households. Table 6 reports the thresholds by food security status for the indicators in the CARI console, namely food energy shortfall, food expenditure, poverty status and livelihood coping strategies.

The 'food energy shortfall' upper and lower thresholds are respectively 2,100 kcal, a widely recognized acceptable caloric requirement per capita, and 1,600 kcal, which is the minimum dietary energy requirement (MDER). The middle threshold is the average between the two – 1,850 kcal.[25]

[22] "[T]he shallower local food and labour markets are, the more prices can be expected to be positively correlated with movements in shadow prices, trapping the household within the range of self-sufficiency" (De Janvry, Fafchamps and Saudolet, 1991).

[23] The shadow price satisfies the equilibrium condition between a household's output and its demand for food (Strauss, 1986; De Janvry, Fafchamps and Saudolet, 1991), and it falls within the boundaries defined by the market price plus or minus household-specific transaction costs τ. Thus, the household would be a net food seller occurring $p_{sell} \leq p_i - \tau$, where p_i is the ratio between the household's marginal utility of endowments in non-tradable goods and the marginal utility of cash.

[24] The CARI guidelines were used in the November 2015 issue: http://www.wfp.org/content/consolidated-approach-reporting-indicators-food-security-cari-guidelines

[25] All these values were re-scaled at household level with an adult-equivalent ratio.

Table 6: Thresholds for CARI indicators

Domain		**Indicator**	**Food secure**	**Marginally food secure**	**Moderately food insecure**	**Severely food insecure**
Current Status	Food Consumption	Food Energy Shortfall	> 2100 kcal	2100 to 1850 kcal	1850 to 1600 kcal	1600 kcal
Coping Capacity	Economic Vulnerability	Food Expenditure Share	< 50%	50% - 65%	65% - 75%	> 75%
		Poverty Status	> 8.75 US$		8.75 - 2.25 US$	< 2.25 US$
	Asset Depletion	Livelihood Coping Strategy	None	Stress	Crisis	Emergency

Source: Author's calculation

The thresholds used for the 'share of food expenditures on total expenditures' and for the 'livelihood coping strategy' are those set out in the guidelines for the CARI console.[26]

The 'poverty status' threshold for food-secure people was set at US$8.75 per week, corresponding to at least US$1.25 per day; the lower threshold was US$2.25 per week.

At a baseline level, 70 percent of the sampled household are food secure (57 percent) or marginally food secure (13 percent). However, poverty is widespread as 90 percent of the sampled population lives with less than US$1.25 per day; 28 percent cannot afford the MDER basket. Some 61 percent of households in the sample spend more than half of their budget on food. The remaining part of the budget is mostly spent on non-food items and services, which are unlikely to change substantially after the shock. Because of the low levels of disposable income, expenditures allocation vary little.

In terms of **food energy shortfall – a proxy for food consumption – the number of severely food-insecure households would jump from 19 percent in the baseline to 31 percent in scenario 1 and 34 percent in scenario 2.** Moderate insecurity would increase in the order of 2 to 3 percentage points, depending on the shocks. Most of the change would be in the number of food-secure households, which would drop from 57 percent to 44 percent in scenario 1 and to 40 percent in scenario 2.

The share of expenditure allocated to food – lumping together the monetization of own consumption, goods received in kind and expenditures in cash – measures a household's **economic vulnerability**: households are more at risk of food insecurity the higher the share of income spent on food. Table 7 shows that the households allocate relatively less to food expenditures after the shock of the drought, and the share of severely insecure households gauged by this indicator falls 7 percentage points, down to 12 percent. The share of the moderately insecure increases by 1 percentage point to reach 14 percent of the sampled population, while the marginally food secure are 2 percentage points fewer than in the baseline. The bulk of the improvement can be seen in the share of food-secure households for

[26] WFP, Consolidated Approach to Reporting Indicators of Food Security (CARI) Guidelines, 2015.

this indicator, which increases 8 percentage points, meaning that 47 percent of households will allocate less than 50 percent of their budget to buying food.

As expected, the impact of the drought is an additional driver of poverty, with a further 3 percent of people dropping below the poverty line. Although this figure may seem small, the headcount ratio of people living below the poverty line was already 90 percent in the baseline period. As such, except for a tiny 7 percent, the entire population can be considered poor. Moreover, 57 percent have a level of expenditure between the two classes, spending less than US$1.25 per day but enough to afford a basic food basket. An 8 percentage point increase in the share of households who spend less than the amount needed to buy a basic food basket would see the proportion of severely-insecure households rise to 36 percent.

According to our simulations, the share of food-insecure households[27] increases in both scenarios, rising from 30 percent in the baseline to 41 percent in scenario 1 and 42 percent in scenario 2. There is a 2 percent increase in the proportion of severely food-insecure households in both scenarios, and a larger share of moderately food-insecure households, who increase by 9 percent in scenario 1 and 10 percent in scenario 2.

Table 7: CARI console comparison

			Baseline				Scenario 1				Scenario 2			
			Food secure	Marginally food secure	Moderately food insecure	Severely food insecure	Food secure	Marginally food secure	Moderately food insecure	Severely food insecure	Food secure	Marginally food secure	Moderately food insecure	Severely food insecure
Current status	Food consumption	Food energy shortfall	57%	13%	12%	19%	44%	11%	14%	31%	40%	11%	15%	34%
Coping capacity	Economic vulnerability	Food expenditure share	39%	29%	13%	19%	47%	27%	14%	12%	48%	26%	12%	14%
		Poverty status	10%		61%	28%	7%		57%	36%	7%		57%	36%
	Asset depletion	Livelihood coping strategy category	63%	22%	14%	1%	63%	22%	14%	1%	63%	22%	14%	1%
Food security index			**30%**	**40%**	**27%**	**3%**	**25%**	**34%**	**36%**	**5%**	**22%**	**36%**	**37%**	**5%**

Source: Author's calculation

The combined result of increasing poverty and plummeting food consumption leads to a smaller share of food-secure households, who decrease by 5 percent in scenario 1 and by 8 percent in scenario 2.

Descriptive analysis by household agricultural income

While food security outcomes in the two scenarios may appear similar, differences become clear when examining income quartiles.

[27] According to the weighted index of the five indicators in the CARI console.

Land availability for the richer group is significantly higher than for the other three groups, with an average of 4.1 hectares owned. The other three groups rely on an average of 3.2 hectares, even though quite surprisingly the lowest income group has slightly more land than the other two. Still, if we analyse the area planted, we find a positive relationship between agricultural income and land access.

Pearl millet returns the highest share of income. In the first wealth group, earnings from pearl millet represent 80 percent. This is because although the reduction in yields (-34 percent) is in line with that of maize (-35 percent), nominal prices per kilo for pearl millet have been steady at US$0.34,[28] while maize prices have fallen 7 percent from the previous season. Households with the highest income from cropping activities balance pearl millet planting with sorghum and maize, benefitting from the higher price per kilo of both crops.

Table 8: Crop income groups and percentage contribution to income by crop type

Crop-income groups	Crop: Maize	Sorghum	P. Millet	F. Millet	Share of irrigated area
Lowest	10%	7%	80%	3%	51%
Med-low	8%	14%	73%	5%	68%
Med-high	11%	20%	62%	7%	70%
High	18%	26%	53%	3%	66%

Source: FoodSECure survey, November 2015. Author's calculation

The combined effects of reduced yields and falling prices naturally impact the food security of the sampled households. Table 9 compares food energy shortfall by income group. In both scenarios, the group with the second highest crop-income level loses the most in relative terms compared to the baseline. The share of households with a food-secure level of food energy shortfall shrinks by 19 percent in scenario 1 and by 24 percent in scenario 2. The share of moderately and severely food insecure in this group reaches 43 percent in scenario 1 and 47 percent in scenario 2. Planting nothing but maize seems to harm the higher income group the most, even though it erodes food security for all the other households as well.

Table 9: Food security categories for the food energy indicator by cropping income levels

	Baseline				Scenario 1				Scenario 2			
Crop Income	Lowest	Med-low	Med-high	High	Lowest	Med-low	Med-high	High	Lowest	Med-low	Med-high	High
Food secure	38%	58%	61%	70%	34%	45%	42%	53%	37%	40%	37%	47%
Marginally food secure	13%	10%	14%	8%	4%	6%	15%	9%	4%	13%	16%	9%
Food insecure	49%	32%	25%	23%	62%	48%	43%	38%	59%	47%	47%	45%

Source: FoodSECure survey, November 2015. Author's calculation

The drop in disposable income will trigger a drop in the overall level of expenditure and then it will affect expenditure allocation.

[28] Average of the price in the post-harvest quarter, compared to the previous season.

Food expenditures are curtailed compared with the baseline values (Table 10). The lowest income group cut their food expenditures by 11 percent in scenario 1 and by 8 percent in scenario 2; the medium-low group reduce theirs by 20 percent in scenario 1 and by 15 percent in scenario 2. By contrast, the medium-high group change how they allocate their budget, reducing food expenditures more in scenario 2 (by 17 percent) than in scenario 1 (by 19 percent). The fall in food expenditures is higher for households who spend most of their budget on food – namely those with the highest income from cropping activities at the baseline. They spend 21 percent less on food in scenario 1 and 28 percent less in scenario 2.

Estimating the food gap in caloric terms, we calculated the volume of wheat needed to cover that gap per month for the overall population. Table 11 shows that over a month the households in need – those consuming less than 1,850 calories per day – required 3,374 kg of wheat to bridge the gap. This need rises to 5,204 kg with the impact of the drought and it would have been as high as 5,430 kg a month, if households had only planted maize.

Table 10: Average food expenditures, percentage drop from baseline

Crop-income group	Scenario 1	Scenario 2
Lowest	11%	8%
Med-low	20%	15%
Med-high	17%	19%
High	21%	28%

Source: Author's calculation

Table 11: Food needed to achieve food security (kg) and number of households in need

	Baseline	Scenario 1	Scenario 2
Wheat Equivalent (kg)	3374	5204	5430
# Households	*121*	*179*	*185*

Source: Author's calculation

The yields of all food crops are very low compared to the record high of season 2008/2009 in Masvingo, when maize crops produced 680 kg/hectare, sorghum 380 kg/hectare, finger millet 440 kg/hectare and pearl millet 380 kg/hectare. This might be because only one third of the land owned by households is irrigated and the area planted is 68 percent of the total arable land. The distribution of the irrigated land is also uneven, more concentrated on households with larger plots, who irrigate an average 52 percent of their land compared with 19 percent for households with smaller plots.

Descriptive analysis by geographical area of residence

There are geographical differences in the simulation outcomes. In fact, the five wards show structurally different characteristics. Table 12 reports a series of indicators disaggregated by ward. Chimbudzi and Gwamatenga register a higher average Food Consumption Score (FCS), with lower values in Chizumba, Mazatese and Dinhe. In the latter, the area planted and expenditures (both food and non-food) are the lowest of the sample. However, Chizumba and Mazatese perform the worst in terms of per capita weekly food expenditures in scenario 2. In the face of lower income, households reduce their per capita weekly expenditures by US$0.5. A further drop is forecast in Chizumba, Gwamatenga and Mazatese under scenario 2. In Chimbudzi, considering the relatively higher baseline food expenditures but with prices in line with the other wards, we expect households would be able to maintain their weekly food expenditures close to the acceptable food basket cost (i.e. US$2.25).

In scenario 1, mixed crops drive a sizable drop in the budget allocated to food expenditures down to US$1.6, except in Chizumba, where just US$1.4 is spent on food. Relying solely on maize crops only reduces food expenditures for households living in Mazetese.

These changes affect household decisions on how to allocate the budget. The fall in available income, and therefore in expenditure, mainly impacts food expenditures, which were on average already below the cost of an acceptable food basket in all wards except Chimbudzi.

Table 12: Food Consumption Score, area planted, and total and food expenditures

	Baseline		Per Capita Weekly Expenditures (US$)			Per Capita Weekly Food Expenditures (US$)		
	FCS	Area Planted (ha)	Baseline	Scenario 1	Scenario2	Baseline	Scenario 1	Scenario2
Chimbudzi	46	2.45	4.5	4.0	4.0	2.4	2.0	2.1
Chizumba	39	2.30	4.2	3.7	3.6	1.7	1.4	1.4
Dinhe	32	1.97	3.8	3.3	3.3	1.9	1.6	1.6
Gwamatenga	44	2.46	4.0	3.5	3.4	2.0	1.6	1.6
Mazetese	36	2.55	4.5	4.0	3.9	1.9	1.6	1.5

Source: Author's calculation

Although prices continue fall – counter to the usual seasonal pattern – and even though this trend is expected to continue, lower amounts allocated to food suggest that households prefer to retain their current levels of non-food expenditure.

The share of households who consume more than 2,100 kcal per capita per day in the baseline was non-geographically homogenous, similarly to the FCS. There is a reduction in the number of households deemed food secure across the board in scenario 1: by 10 percentage points in Chimbudzi and Dinhe, 12 percentage points in Chizumba, 16 percentage points in Mazatese and 17 percentage points in Chizumba. Scenario 2 portrays an even worse situation. The loss of caloric consumption in the simulation in scenario 2 increases the number of marginally food-secure households, especially in Chizumba, Dinhe and Gwamatenga. The increase in the number of food-insecure households is around 2 percentage points in all the wards, generating further stress in Mazetese where 64 percent of households are expected to be food insecure, and in Dinhe, where the share is forecast to be 59 percent. Many more households would fall into food insecurity in Chizumba, with the share rising 19 percentage points from baseline in scenario 2, to reach 51 percent. In scenario 2, Gwamatenga would see 40 percent of the population classified as food insecure according to the food energy shortfall indicator; the share would be 35 percent in Chimbudzi.

Table 13: Food Energy Shortfall Indicator by ward

Ward	Food secure			Marginally food secure			Moderately and severely food insecure		
	Baseline	Scenario 1	Scenario2	Baseline	Scenario 1	Scenario2	Baseline	Scenario 1	Scenario2
	Diversified production	Diversified production	Maize only production	Diversified production	Diversified production	Maize only production	Diversified production	Diversified production	Maize only production
Chimbudzi	68%	58%	56%	8%	9%	9%	24%	33%	35%
Chizumba	54%	42%	38%	14%	8%	11%	32%	50%	51%
Dinhe	45%	35%	31%	12%	8%	11%	43%	57%	59%
Gwamatenga	68%	51%	45%	14%	10%	14%	18%	39%	40%
Mazetese	47%	31%	29%	7%	7%	7%	46%	61%	64%

Source: Author's calculation

Descriptive analysis by household expenditures

We designed another grouping using the quartiles of total expenditures per capita. These segregation criteria were already effective in the baseline, showing that households with lower income were more vulnerable. In particular, 49 percent of them consumed less than 1,850 kcal per day; 32 percent and 29 percent of the two middle groups fell under this threshold, while only 19 percent of the higher expenditure group consumed less than 1,850 kcal per day. Table 14 reports some characteristics of these groups. The food consumption score seems proportional with the expenditure groups and particularly penalizes the lower end of the distribution. The average area planted is not significantly different by expenditure group, with 2.1 hectares planted by households with lower total per capita expenditures and 2.4 hectares for the other households.

An indicator of the food gap in wheat equivalent per month has been calculated to understand how much food[29] each person would need to cope with the reduction in food security without eroding their own resources by resorting to more severe coping strategies. The objective is to achieve at least the 1,850 kcal per capita per day requirement. The quantity of food needed by households is estimated at 2.5 kg per person per month for the lowest expenditure group, 1.0 kg and 1.2 kg for the two middle groups and 0.6 kg for the higher category households. This indicator gives also information on the depth of the food gap faced by the sampled households, combined with the share of moderately and severely food-insecure households as defined by food energy shortfall. The lowest end of the distribution of the total per capita expenditure needs more additional food per month in scenario 2 than in scenario 1, despite a small drop in the share of moderately and severely food-insecure households. This could also be interpreted as the higher state of deprivation of the many households who do not achieve food security. For the poorest households, planting maize alone results in deeper insecurity for 66 percent of them.

[29] Wheat equivalent conversion of the caloric requirement to meet the threshold, here set at 1,850 kcal/person/day.

The shares of households in the lowest food security category remain unchanged between the two scenarios in the middle-low expenditure group, increasing from 32 percent in the baseline to 51 percent; the quantity of food needed per person rises from 1 kg per month in the baseline to 1.8 kg in scenario 1 and up to 2 kg in scenario 2.

The food energy shortfall indicates that 29 percent of the households in the medium-high expenditure group were food insecure in the baseline, with a gap of 1.2 kg per person per month. In scenario 1 this gap increases to 1.9 kg and the share of food insecure households goes up by 16 percentage points. In scenario 2 the same group faces even worse conditions, with the share of food insecure households rising a further 4 percentage points, while the food gap widens by an average 0.1 kg.

The higher category in the total per capita expenditure grouping is composed of 19 percent food-insecure households who need 0.6 kg per person per month in the baseline.

In scenario 1 these two values increase by an average of 9 percentage points and 0.5 kg; they reach 32 percent and 1.2 kg in scenario 2.

Table 14: Area planted and food security indicators by per capita expenditure quartiles

Expenditure Group	Baseline		Per capita marginally food secure food gap (kg/person/month)			Moderately and severely food insecure		
	FCS	Area planted (ha)	Baseline	Scenario 1	Scenario 2	Baseline	Scenario 1	Scenario 2
Low	32	2.1	2.5	3.5	3.6	49%	68%	66%
Med-low	39	2.4	1.0	1.8	2.0	32%	51%	51%
Med-high	41	2.4	1.2	1.9	2.0	29%	45%	49%
High	46	2.4	0.6	1.1	1.2	19%	28%	32%

Source: Author's calculation

We used the dependency rate, expressed as the ratio between the number of household members under 18 or over 60 and the adult population, to divide the population sampled into quartiles.

The distribution shows an asymmetric concentration around the lower-central group, revealing the prevalence of a structure of households with an average 1.7 individuals of non-working age per individual of working age. The right tail of this distribution is heavy, showing households with a high dependency ratio. Households with higher dependency rates seem particularly vulnerable; this seems to remain relatively unchanged after the simulated shock.

Table 15: Groups by quartiles of rate of dependency and Food Energy Shortfall

Rate of dependency	Household count	Min	Average	Max	Moderately and severely food insecure: Baseline	Scenario 1	Scenario 2
Low	96	0	0.8	1	24%	42%	45%
Medium-Low	129	1.3	1.7	2	36%	53%	55%
Medium-High	68	2.3	2.7	3	32%	41%	41%
High	81	3.3	5.0	9	37%	52%	53%
Total	*374*	*0*	*2.4*	*9*			

Source: Author's calculation

The groups with the greatest share of households with food energy shortfalls are those with medium-low dependency (36 percent) and high dependency (37 percent); these proportions are expected to rise to 53 percent and 52 percent in scenario 1 and to 55 percent and 53 percent in scenario 2. In the lowest group, where the dependency ratio is between 0 and 1, households have the highest per capita expenditures. Unsurprisingly, these households have the lowest share of food insecurity at the baseline level; but this share rises by 18 percentage points in scenario 1 and by 21 percentage points in scenario 2. The medium-high group has a 32 percent of prevalence of households who do not meet the requirement of 1,850 kcal per person per day. This rises to 41 percent and remains stable in the simulations of both scenarios.

Descriptive analysis by gender of household head

Households headed by women represent 26 percent of the total sample. Table 16 presents a range of indicators chosen to underline the different characteristics of these households.

Table 16: Set of indicators at baseline time by gender of the household head

Gender of Household Head	Baseline: Land Area (ha)	of which planted	Production (kg): Maize	Sorghum	Pearl Millet	Finger Millet	FCS	Dependency Rate
Male	3.7	68%	37	57	147	11	40	2.3
Female	3.0	64%	32	44	105	4	38	2.6

Source: Author's calculation

Households headed by men have more land available to cultivate and a higher proportion of their land is actually planted. Similarly, these households have higher average production for all crops and a higher average FCS. The reasons for the disparity in production could be household size and dependency rate, as reported in Table 17. Households headed by women are usually smaller and have a higher dependency rate; therefore, the workforce available inside the household is generally more limited.

Table 17: Household size and dependency rate by gender of household head

Gender of Household Head	Household Size	Dependency Rate
Male	6.7	2.3
Female	5.8	2.6

Source: Author's calculation

Table 18: Share of food expenditures over total expenditures, baseline data

Gender of Household Head	Share of food expenditure on total		
	Baseline	Scenario 1	Scenario 2
Male	52%	49%	49%
Female	62%	58%	58%

Source: Author's calculation

Households headed by women have to rely more on the market for their consumption, and this is reflected in the share of their budget allocated to food expenditures (see Table 18). Although the shock causes this proportion to drop slightly, food expenditure continues to represent a high percentage of total expenditure, showing that most of these households do not have the means to change their consumption patterns and expenses without large shocks.

Table 19: Households with Food Energy Shortfall food insecurity by gender of household head

Gender of Household Head	Moderately and severely food insecure		
	Baseline	Scenario 1	Scenario 2
Male	28%	44%	46%
Female	44%	60%	59%

Source: Author's calculation; moderate insecurity threshold set at 1,850 kcal per person per day

This state of poverty is more concerning if we look at food energy shortfall disaggregated by gender of household head. As reported in Table 19, the baseline status of the households headed by women was already more vulnerable compared with that of households headed by men. The spread between the two types of household does not vary between baseline and scenario 1, remaining stable at 16 percentage points. With scenario 2, we see a small increase in the prevalence of food insecurity among households headed by men according to the food energy shortfall indicator, and a small decrease in prevalence among those led by women. The lower yields and production levels of the latter present less of a concentration of the cropping activity on maize only; even so, the share of insecure households remains at 59 percent.

4. Concluding remarks

The SISMod analysis built on the November 2015 questionnaire of the Small Grains project underlines the impact that the current drought will have on household behaviour – such as by changing expenditures and food consumption – and how households would have responded if they had planted only maize.

The different representative groupings built using the baseline data help understand which households are the most vulnerable to shocks. We discovered that none of the households will benefit from the almost irrelevant drop in prices because the fall in production will be much greater.

Staple crop production was expected to cover 70 percent of households' annual food requirements; after the shock, production will cover 55 percent. In the absence of the project and assuming the cultivation of maize only, crop production would have covered only 42 percent of the food requirement.[30]

Household decisions are always constrained by very high poverty (93 percent of the population in both scenarios) and inelastic non-food expenditures.

We estimated that the project brought on average 11 percent more production value (in US$) if compared with the cultivation of maize alone.

Households in Gwamatenga and Chizumba wards seem to benefit more from the production of small grains. The endowment of productive assets of those households was also significantly higher than in other wards, a probable result of previous WFP projects. The small grains project succeeds in mitigating insufficient caloric intake for households who spend less and for those who have a lower income from cropping activities.

However, in Mazatese and Dinhe – two wards with the highest share of households who consume less than 1,600 kcal/person/day or who are highly food insecure – beneficiaries seem not to profit significantly from the intervention. Their current situation appears to be linked to the high levels of food insecurity in the baseline assessment.

The drop in production left households headed by women more vulnerable than those headed by men. The yield for the main crop, pearl millet, is much lower for the former, despite the competitiveness in other crops. Baseline assessment shows that these households have smaller plots, less irrigated land and a smaller workforce within the household.

A continuous effort to improve the yields of more vulnerable households is necessary to build their capacity to provide food for their families and stabilize their food security, even in the face of a price or production shock.

[30] Calculated on the basis of the cost of food basket and the monetary value of the staple crop production.

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