Zimbabwe: Agriculture Sector Disaster Risk Assessment

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Building Disaster Resilience in Sub-Saharan Africa

An initiative of the African, Caribbean and Pacific Group of States funded by the European Union

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ABBREVIATIONS AND ACRONYMS

AGRITEX	Agricultural Technical and Extension Services
AIS	Agricultural Innovation System
ARC	African Risk Capacity
ARDA-DDP	Agriculture and Rural Development Authority – Dairy Development Program
ASP	Adaptive Social Protection
CADRI	Capacity for Disaster Reduction Initiative of the United Nations
CERF	Central Emergency Response Fund of the United Nations
CIAT	International Center for Tropical Agriculture (Centro Internacional de Agricultura Tropical)
CIMMYT	International Maize and Wheat Improvement Center (Centro Internacional del Mejoramiento de Maíz y Trigo)
CPO	Civil Protection Organization
DCP	Department of Civil Protection
DR-SS	Department of Research and Specialists Services
DRM	Disaster risk management
ENSO	El Niño Southern Oscillation
EWS	Early warning system
FAO	Food and Agriculture Organization of the United Nations
FAOSTAT	Food and Agriculture Organization statistical database
FNC	Food and Nutrition Council
GDP	Gross domestic product
GFDDR	Disaster Risk Financing Facility
GMB	Grain Marketing Board
GoZ	Government of Zimbabwe
GVP	Gross value of production
ICT	Information and communication technology
LaR	Loss at risk
MAMID	Ministry of Agriculture, Mechanization and Irrigation Development
MLACWRR	Ministry of Lands, Agriculture, Climate, Water and Rural Resettlement
MLARR	Ministry of Lands, Agriculture and Rural Resettlement
MoFED	Ministry of Finance and Economic Development

NADF	National Association of Dairy Farmers
NCCRS	National Climate Change Response Strategy
NCPCC	National Civil Protection Coordination Committee
NDVI	Normalized difference vegetation index
NGO	Non-governmental organization
OCHA	Office for the Coordination of Humanitarian Affairs (United Nations)
PML	Probable Maximum Loss
PQS	Plant Quarantine Service
R&D	Research and development
SGR	Strategic Grain Reserve
SPS	Sanitary and phytosanitary
UN	United Nations
UNDP	United Nations Development Programme
UNICEF	United Nations Children's Fund
USAID	United States Agency for International Development
WII	Weather Index Insurance
ZFU	Zimbabwe Farmers Union
ZCFU	Zimbabwe Commercial Farmers Union
ZDFA	Zimbabwe Dairy Farmers Association
ZIMSTAT	Zimbabwe National Statistical Agency
ZimVAC	Zimbabwe Vulnerability Assessment Committee

EXECUTIVE SUMMARY

This report presents an assessment of Zimbabwe's agriculture sector disaster risk and management capacity. The findings indicate that Zimbabwe is highly exposed to agricultural risks and has limited capacity to manage risk at various levels. The report shows that disaster-related shocks along Zimbabwe's agricultural supply chains directly translate to volatility in agricultural GDP. Such shocks have a substantial impact on economic growth, food security, and fiscal balance.

When catastrophic disasters occur, the economy absorbs the shocks, without benefiting from any instruments that transfer the risk to markets and coping ability. The increasing prevalence of "shock-recovery-shock" cycles impairs Zimbabwe's ability to plan and pursue a sustainable development path. The findings presented here confirm that it is highly pertinent for Zimbabwe to strengthen the capacity to manage risk at various levels, from the smallholder farmer, to other participants along the supply chain, to consumers (who require a reliable, safe food supply), and ultimately to the government to manage natural disasters.

The assessment provides the following evidence on sources of risks and plausible risk management solutions. It is our hope that the report contributes to action by the Government of Zimbabwe to adopt a proactive and integrated risk management strategy appropriate to the current structure of the agricultural sector.

Agricultural Risk Exposure

1. **Zimbabwe loses approximately US$126 million each year due to production risks**. These losses represent 7.3 percent of agricultural GDP. Moreover, the losses change from year to year, for example, the value of crop losses was estimated at US$321 million in the drought year of 2001 and reached a virtually catastrophic level—US$513 million—in 2008.
2. **The most important agricultural risk in Zimbabwe is drought**. It affects agricultural production and food security. For example, the 2015/16 drought induced by ENSO caused agricultural output to fall and an estimated 4 million people were food insecure in 2016. Increasingly frequent and severe droughts in southern and western Zimbabwe are making these areas unsuitable for rainfed maize production highlighting the need to reconsider the boundaries and crop suitability patterns established for Zimbabwe's agro-ecological zones. Other weather-related risks are also frequent but have lower and more isolated impacts. Sanitary and phytosanitary risks are common among all crops and livestock; they are usually managed if agrochemicals and vaccines are available, and farmers have resources to purchase them. Price volatility has also been reported as a risk, and price stabilization policies are perceived to have added more uncertainty to the market.
3. **Poor farmers are most exposed to production and market risks.** Not only are they more exposed to risks, but their initial vulnerability is higher, and they have a lower capacity to manage agricultural risks. In sum, managing a great portion of agricultural risks in Zimbabwe will require that special attention is given to building

resilient, diversified agriculture for smallholder farmers in these high risk exposed areas.

4. **To a great extent, the management of agricultural risk in Zimbabwe depends on the capacity of smallholders**, who dominate agricultural production. Yet, smallholders have limited ability to reduce such risks on their own. In this context, the public sector can play an important role in supporting the agricultural sector by (1) assisting farmers in strengthening their resilience at the farm level to improve production and productivity and (2) by providing timely disaster response support after high-impact events. The capacity of the public sector to provide the necessary support appears weak, however.
5. **Important gender asymmetries in asset ownership and access to services leave women farmers more exposed to risks compared to male farmers**, and render them less able to mitigate the risks or cope with them as they occur. In Zimbabwe, women constitute 54 percent of the agricultural labor force, but men have better access to land than women. Currently, 18 percent of A1 farmers and 12 percent of A2 farmers are female farmers; collectively they have access to 10 percent of the land redistributed under the Fast Track Land Reform. Women own 1,900 of the 18,000 farms in the A2 zone. In the commercial farming sector, 80 percent of cattle are owned by men and 20 percent by women, while on communal farms only 35 percent of cattle are owned by women.

Towards a Risk Management Strategy

6. **An integrated risk management strategy is needed.** The report recommends the need to start the process towards an integrated risk management strategy with a package of interventions related to mitigating risk at farm level, possibilities to transfer agricultural risk to financial markets, and adopting a proactive disaster risk financing strategy to cope with risk at catastrophic levels.
7. **Risk mitigation at farm level as a priority**. An integrated agricultural risk management strategy for the current context in Zimbabwe must promote risk mitigation measures at the farm level as a priority. This requires a leap-frogging approach in Agriculture Innovation Systems. The approach can strengthen the capacity to reduce risk and improve resilience at the farm level. The report identifies three areas in which the Agriculture Innovation System will benefit from leap-frogging:
   - Shifting the paradigm from conventional, high-input agriculture to knowledge-intensive sustainable intensification of agriculture;
   - Leaping from uniform production patterns to more specialized production in a spatial development framework; and
   - Pursuing the digitalization of agriculture. If the Agriculture Innovation System is to undertake these strategic approaches, it will require policy support and investments to strengthen the public and private institutions that support smallholder farmers and bring about change.
8. **Risk transfer mechanisms have the potential to transfer the residual risk to the capital markets**. Agricultural insurance is one potential risk transfer tool that farmers and other stakeholders can use to manage risks that cannot be mitigated at the farm level. Insurance instruments transfer part of that risk to another party in return for a fee (or premium). Where it is available and affordable, agricultural insurance (for crops and/or livestock) under public-private partnership arrangements can greatly benefit large groups of farming households:
   - Insurance can (and should) be used to complement other risk management approaches. In the event of a major weather shock, insurance can be designed to protect against revenue or consumption losses, enabling households to avoid selling critical livelihood assets or drawing on savings.
   - Insurance can assist farmers in accessing new opportunities by improving their ability to either borrow money or in-kind credits. In doing so, farm households may potentially experience higher returns.
   - Innovative risk transfer programs such as agricultural insurance at the sovereign and farmer level are being implemented in various sub-Saharan countries. These programs could provide valuable lessons on how to transfer agricultural risk to capital markets in Zimbabwe.
9. **Disaster risk financing needs to be proactive**. Disaster risk financing in Zimbabwe has relied on humanitarian funds owing to the severe

fiscal constraints of the government balance sheet, and this situation is likely to continue until the economy revives. The government earmarks around US$35 million a year for contingencies. In times of tight budgeting, that fund is meant to cover many other contingencies arising from all sectors of the economy and not only those arising from natural disasters. In practice, the government makes relatively small allocations on a yearly basis for immediate rescue and emergency operations following disasters, recognizing that humanitarian assistance takes time to approve and disburse. Yet even if the government were to allocate all of its contingency funds to natural disasters and emergencies, it would not cover the estimated average annual gap. There are no financial margins to cushion the effects of agricultural risk and natural disasters, and the country absorbs the shocks without transferring any of the risks to markets.

10. In summary, Zimbabwe should start transitioning away from its current reactive strategy for managing disaster and agricultural risks and move toward a proactive integrated risk management strategy that combines improvements for managing risk at the farm level, risks transfer mechanisms and effective catastrophic risk management strategy.

Chapter 1

INTRODUCTION

Agricultural risk has been a continuing concern of the Government of Zimbabwe (GoZ), owing to agriculture's pivotal role in Zimbabwe's economy with respect to jobs, incomes, exports, and poverty reduction. Agriculture accounts for 11 percent of gross domestic product (GDP) and is the main source of livelihood, employment, and income for around 67 percent of the population.[1] Agricultural output through the years has shown considerable volatility, resulting in high losses in the agricultural sector. As this assessment will demonstrate, Zimbabwe loses approximately US$126 million each year on average due to production risks that could be better managed. These losses represent 7.3 percent of agricultural GDP. Losses in years when production risks are high can escalate to virtually catastrophic levels. For example, losses in the drought year of 2001 were estimated at US$321 million, and in 2008, when agriculture was seriously affected by drought and financial restrictions, losses escalated to US$513 million. Such losses have a direct impact on growth, food security, and fiscal balances. Recently, effects of the El Niño Southern Oscillation (ENSO) during the 2015/16 cropping season produced low rainfall and drought, which led to large food deficits. At the peak of the lean season prior to the subsequent harvest in 2017, an estimated 4 million people needed temporary food assistance.[2]

Strengthening Zimbabwe's resilience to agricultural risk, particularly the resilience of its small-scale producers, is becoming a key development priority as a way of making agricultural investments more sustainable, strengthening food security, and reducing rural poverty. The objective of this risk assessment, which was undertaken by the World Bank at the request of the Government of Zimbabwe (GoZ),[3] is to inform GoZ decisions on agricultural risk management and risk financing strategies. The assessment provides analytical evidence on sources of risks and plausible risk management solutions. The findings and recommendations emerging from this assessment are intended to contribute to the adoption of a proactive and integrated risk management strategy that is appropriate to the current structure of the agricultural sector.

With those objectives in mind, this report is organized as follows. This first chapter provides contextual information on Zimbabwe's agricultural sector and the methodology used to conduct the disaster risk assessment. Chapter 2 presents estimates of the annual average losses incurred in the agricultural sector due to production risk at different levels of intensity. Risk profiles developed for key agricultural commodities and livestock are described in Chapter 3 and used to prioritize agricultural risks for the sector as a whole. Chapter 4 presents an evaluation of the capacity to manage agricultural risks at different levels. Recommendations for an improved risk management system are discussed in Chapter 5. Chapter 6 offers concluding remarks.

1.1 Overview of the Agricultural Sector

Aside from contributing 11 percent of GDP and supporting the livelihoods of approximately 67 percent of the population, agriculture also serves as the backbone of Zimbabwe's largely agro-based industrial sector. Agriculture-related employment supports one-third of the formal labor force.

Most agricultural land has been worked by small-scale producers since the Fast Track Land Reform

Table 1. Land Holdings Before and After the Introduction of Fast Track Land Reform, Zimbabwe

Land category	Area (million ha)		
	1980	2000	2009
Communal area	16.4	16.4	16.4
Old resettlement	0.0	3.5	3.5
New resettlement A1	0.0	0.0	4.1
New resettlement A2	0.0	0.0	3.5
Small-scale commercial farms	1.4	1.4	1.4
Large-scale commercial farms	15.5	11.7	3.4
State farms	0.5	0.7	0.7
Urban land	0.2	0.3	0.3
National parks and forest land	5.1	5.1	5.1
Unallocated land	0.0	0.0	0.7

Source: Kasiyano 2017.
Note: Inhabitants of communal areas do not possess title to the land, which is communally owned and allocated to families for arable farming and settlement. "Old resettlement" refers to areas where land was redistributed in the 1980s. The two main groups benefiting from land redistribution during and after the 1990s are smallholders (the "new resettlement A1" group) and medium-scale producers (the "new resettlement A2" group).

was introduced after 2000. Table 1 shows that the area dedicated to large commercial farms decreased from 15.5 million hectares in 1980 to 3.4 million hectares in 2009. The fact that agriculture is dominated by small-scale production presents important challenges to the government with respect to increasing productivity, linking producers to markets, and managing risk.

Zimbabwean agriculture is widely diversified, owing to diverse agro-climatic conditions that make it possible to produce over 20 types of food and cash crops as well as poultry, pigs, and dairy and beef cattle. The most important agricultural commodities are the staple food grains that constitute the basis of local diets—maize, wheat, small grains (millet and sorghum), groundnuts, and beans—and export and cash crops (mainly tobacco, cotton, sugarcane, and horticultural crops). Appendix A contains detailed descriptions of the importance, performance, and governing structure of each of these supply chains.

Four of these commodities play particularly critical roles. Maize is the main staple food crop and therefore at the center of national food security. Groundnuts are critical for household nutrition. Tobacco is the major agricultural export commodity, contributing 25.2 percent of agricultural GDP in 2016, accounting for over 50 percent of agricultural exports, and representing an average of 29 percent of the country's total exports in 2016 and 2017.[4] Cotton is a crop of strategic importance for promoting inclusive economic growth, poverty alleviation, rural development, and food security in Zimbabwe, because in various regions cotton production offers the main link to markets and is a key component of livelihood strategies among isolated and vulnerable rural households. After tobacco, cotton is Zimbabwe's second or third (together with sugar) largest agricultural foreign exchange earner, contributing 12.6 percent to agricultural GDP.

1.2 Methodology Used for This Risk Assessment

To undertake this assessment, the team used an established participatory methodology developed by the World Bank that prioritizes agricultural risks across a set of representative agricultural commodities.[5] A comprehensive framework is used to assess and effectively start the process of managing systemic risks to the agricultural sector by assessing the frequency and intensity of observed risks, which makes it possible to estimate the value of their impacts. An understanding of agricultural stakeholders' capacity to manage risk in specific supply chains also helps to prioritize the most important risk management investments.

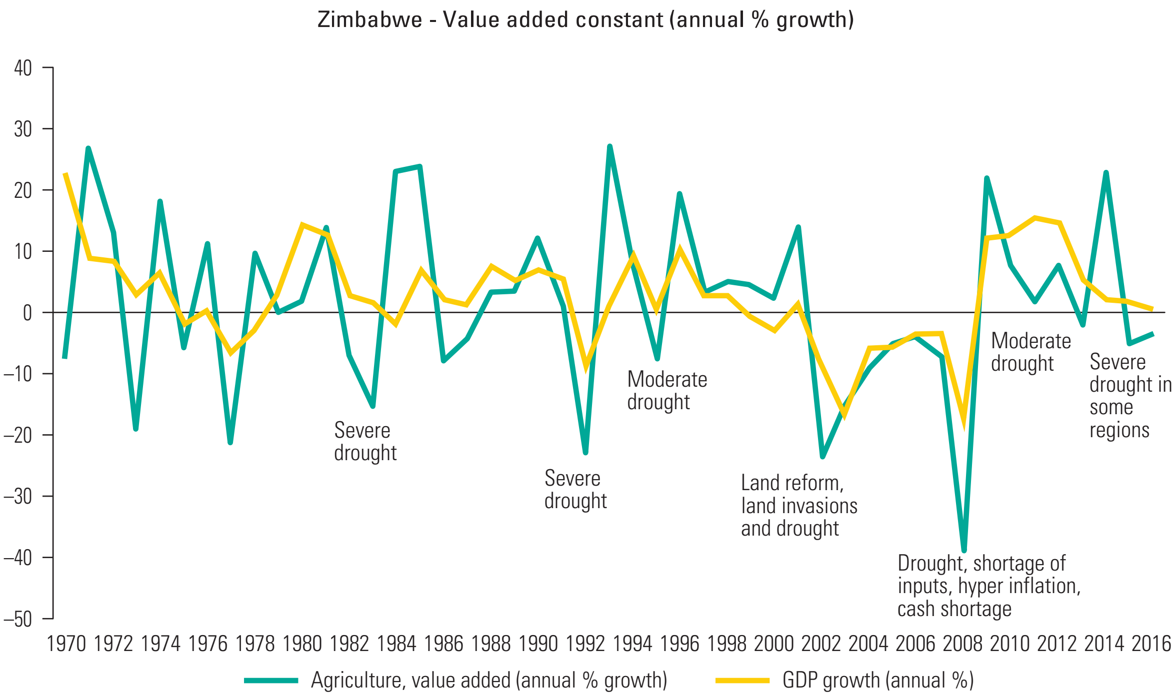
The agricultural supply chains selected for this assessment (Table 2) represent 90 percent of the total agricultural value added, measured as an average of the last five years, and they use most of the agricultural land.[6] Within this group of products, maize (as noted) is the main staple food, and tobacco is a major export product (second only to minerals as a source of export proceeds). Risks identified along the supply chains for these commodities can help to reveal the drivers of volatility in agricultural growth,

Table 2. Zimbabwe: Main Agricultural Commodities Included in the Risk Assessment

Agricultural commodity	Percentage of agricultural GDP (average 2012–16)*	Area (average 2012–16) (ha)**	Exports (average 2012–16, US$ 000s)***
Tobacco	36.08%	91,816	879,198
Cattle production (beef and dairy)	10.81%		34,059
Maize	10.07%	1,460,810	790
Cotton	9.89%	224,923	103,214
Sugarcane	6.59%	45,961	102,848
Horticulture (fruits, vegetables, etc.)	6.59%	69,612	18,072
Poultry	6.23%		
Wheat	2.38%	12,497	
Groundnuts	1.83%	258,597	
Total	***90.48%***	***3,452,125***	***3,197,974***

Source: * Ministry of Agriculture of Zimbabwe, Agricultural Statistical Bulletin, 2016; ** Ministry of Agriculture of Zimbabwe, Agricultural Statistical Bulletin, 2016 and FAOSTAT (sugar, horticulture, total); *** International Trade Center.

Figure 1. Relationship Between Agriculture Value Added and Overall GDP Growth



Source: Based on WDI 2017.

the sources of food insecurity in the country, and the need for risk financing at different levels of intensity.

Shocks along these supply chains directly translate into volatility in agricultural GDP, aside from having impacts on overall economic growth. Figure 1 illustrates the correlation between agricultural GDP and overall GDP growth. More specifically, it shows the impact of severe and moderate drought in slowing growth both within the sector and the economy as a whole.

Notes

1. WDI (2017).
2. ZimVAC (2016).
3. In this report, "agricultural risk" is understood as an unexpected and sudden event that has the potential to cause losses to stakeholders in the agricultural sector.
4. Reserve Bank of Zimbabwe (2017).
5. World Bank (2016a).
6. Appendix D presents a detailed description and analysis of risk and production losses for food and cash crops.

Chapter 2

AGRICULTURAL RISK EXPOSURE

An agricultural risk assessment aims to arrive at a short list of risks that are key priorities because they are the main drivers of agricultural volatility. That process begins by estimating the overall losses incurred by the agricultural sector as a result of production risks at the farm level;[1] those losses will reveal the relative magnitude of the impact of agricultural risk. Note that the figures presented here do not include post-harvest losses and losses incurred by the sector due to price volatility and market-related risk.

2.1 Production Losses

Since agricultural production is exposed to normal inter-annual variations and occasional shocks caused by weather, disease, and factors related to markets and policy, it is pertinent to identify the main systemic shocks that affect output beyond manageable thresholds.[2] The data available on actual losses are not always accurate or consistent enough to facilitate comparisons and to rank the costs of adverse events. The analysis presented here is thus based on estimates of the "indicative" value of potential losses over the longest period that historical data allow. For the purpose of this assessment and considering the data available, the period analyzed is 1986–2016, using national statistics provided by the Ministry of Agriculture, Mechanization and Irrigation Development (MAMID).

The indicative value of agricultural output lost for a particular year is calculated as the downward yield deviation from the historic trend.[3] The quantification of losses presented here is based on yield data for tobacco, maize, wheat, seed cotton, groundnuts, and sugarcane—the six crops that account for 68 percent of agricultural GDP—and thus captures all production risks such as drought, floods, and pest and disease outbreaks.

Based on this methodology (described in Appendix B), the aggregate value of production losses in those six crops, arising from production risks realized between 1986 and 2016 and monetized at 2016–17 prices, is shown in Table 3. In brief, over 1986–2016, production risks led to losses in crop production valued at approximately US$126 million per year on average, representing an annual average loss of around 7.3 percent of agricultural GDP. As noted in Chapter 1, the value of crop losses was estimated at US$321 million in the drought year of 2001 and reached a virtually catastrophic level—US$513 million—in 2008, when drought as well as financial restrictions seriously affected agriculture. The sources of risk that are driving this output volatility are described in the following chapter, and a more detailed explanation is available in Appendix D.

Maize and sugarcane accrued the largest average losses, though maize was produced on 1.2 million hectares against 45,000 hectares of sugarcane (in 2016). Sugarcane suffered only three severe droughts, but losses were very high in 1991/92. Tobacco, planted on 108,000 hectares in 2015, suffered through four droughts with more modest losses than maize and sugarcane (30,000–58,000 tons).

In line with the aims of this disaster risk assessment for agriculture, these estimates have demonstrated the impact of weather-related risks over the past 30 years, but it is important to consider that climate change will have impacts on Zimbabwe's agricultural sector over and above the weather-related disasters that are the

Table 3. Estimated Volume and Value of Crop Losses in Zimbabwe (Average of 30 Years, 1986–2016)

Crop	Percentage of agricultural GDP (average 2012–16)	Annual average losses (30 years) due to production risks (US$)	Annual average losses (30 years) as percentage of agricultural GDP	Losses 2001 (US$)	Losses 2008 (US$)
Tobacco	36.8%	19,804,922	1.15%	0	184,527,678
Maize	10.1%	44,601,263	2.59%	241,748,598	273,905,499
Seed cotton	9.9%	4,151,986	0.24%	22,483,106	23,791,027
Sugarcane	6.6%	47,015,487	2.73%	0	0
Wheat	2.8%	3,393,939	0.20%	0	31,066,372
Groundnuts	1.8%	7,056,972	0.41%	57,746,716	0
Total 6 crops	***68%***	***126,024,570***	***7.33%***	***321,978,420***	***513,290,577***

Table 4. Estimated Loss at Risk (LaR) for a Portfolio of Crops at Different Return Periods

Recurrence period (years)	10	25	50	100	150	200	250	500
LaR (% exposure)	27.17%	32.94%	36.28%	39.93%	41.77%	42.92%	44.23%	46.67%
LaR (US$ millions)	256.7	311.2	342.8	377.3	394.7	405.6	417.9	441.0

Source: Based on data from MAMID and FAOSTAT.
Note: The crops are coffee, cotton, groundnuts, maize, sorghum, soybeans, sugarcane, tobacco, and wheat.

focus of this assessment. For example, a recent study using a Computable General Equilibrium Model has found that under a dry/hot future climate scenario, Zimbabwe may lose about 2.3 percent of its 2030 GDP—or up to US$370 million.

2.2 Production Losses for Different Return Periods

Severe losses in agricultural production may arise in Zimbabwe as a result of adverse events that recur periodically, sometimes over relatively short spans of time. A production risk assessment was performed for a selected portfolio of nine crops in Zimbabwe over different periods of recurrence.[4] The crop portfolio may face a loss equivalent to 27.2 percent of the national crop gross value of production (GVP)[5] equivalent to US$256.7 million in 1 of every 10 years, crop losses of 39.9 percent of the national GVP (or US$377.3 million) in 1 of every 100 years, and crop losses of 44.23 percent of GVP (US$417.9 million) in 1 of every 250 years (Table 4). For details on the calculations, see Appendix C.

The current structure of the agricultural sector (that is, the dominance of small-scale producers), the changes in technology arising from the shift from large-scale production to small-scale production, and the effects of climate change all demand a new approach to managing agricultural risk. Going forward, the agricultural risk management strategy in Zimbabwe will need to be proactive and holistic, including public support to build risk mitigation/adaptation capacity for smallholders as well as ex-ante financing instruments that can be used to protect smallholders' livelihoods from disasters of various levels. The following chapter provides a basis for developing such a strategy by prioritizing the major production risks.

Notes

1. The detrending analysis consisted of a weighted average of a lineal detrending and a polynomial of second order detrending. Both show a similar trend. The period considered for the detrending comprised the full series (1986–2016). During this period, the land reform and changes in property rights at the beginning of 2000 severely affected agricultural output. Additionally, Zimbabwe experienced successive droughts from 2001 to 2008, followed by a season of excessive rain, when annual production started to increase, spurred on by deregulation. Since it is not possible to differentiate the impacts of changes in the production environment from the effects of the drought/excessive rainfall seasons, the series was not adjusted, which means that these estimates must be interpreted with caution. See Appendix C for technical details.

2. The smaller inter-annual variations in yield that can be part of the cost to farmers of doing business.

3. See Appendix B. Yield deviations are calculated with respect to the historic trend line of the yields. Then, those years in which the negative deviations are greater in absolute value than the standard deviation of the deviations are taken as the years in which significant risk events occur.

Then, for those years, the deviations from the trend are multiplied by the harvested area. This approach makes it possible to estimate the volume of production losses. Next, losses in value are calculated by multiplying the volume of losses by the price of crops. Note that the assessments of market risk and enabling environment risk use a different methodology based on price series analysis and stakeholder interviews.

4. The analysis covered coffee, cotton, groundnuts, maize, sorghum, soybeans, sugarcane, tobacco, and wheat in the aggregate for the whole country. The analysis was based on country-level data on crop area, production, and yields for the period 1986, up to and including 2015 and 2016 prices.

5. For this report, the GVP measures the total value of goods produced by the whole portfolio under study.

Chapter 3

SOURCES OF RISK

To isolate the most important risks that drive volatility in agricultural GDP and food insecurity at the national level, this chapter identifies and prioritizes production risks for each of the agricultural commodities and livestock production activities studied for this assessment.[1] The discussion begins with a review of Zimbabwe's agro-ecological regions and then moves on to present the results of the risk identification and prioritization analysis. Results of that analysis are used to formulate the potential agricultural risk management strategies described in later chapters.

3.1 Agro-ecological Regions

Zimbabwe is a landlocked country divided into five agro-ecological regions defined by their rainfall regime, soil quality, and vegetation, among other factors (Figure 2).[2] In general, farm households in Regions II and III allocate 40–50 percent of the arable land under cultivation to food crops. The proportion rises to 60–70 percent in the dry Regions IV and V.[3]

Region I lies in the east and is characterized by rainfall of more than 1,000 millimeters per year (which falls throughout the year), low temperatures, high altitude, and steep slopes. The country's timber production is located in this region. Region I is ideally suited for intensive diversified agriculture and livestock production, mainly dairy farming. Common crops are tropical crops such as coffee and tea, deciduous fruits such as bananas and apples, and horticultural crops, such as potatoes, peas, and other vegetables.

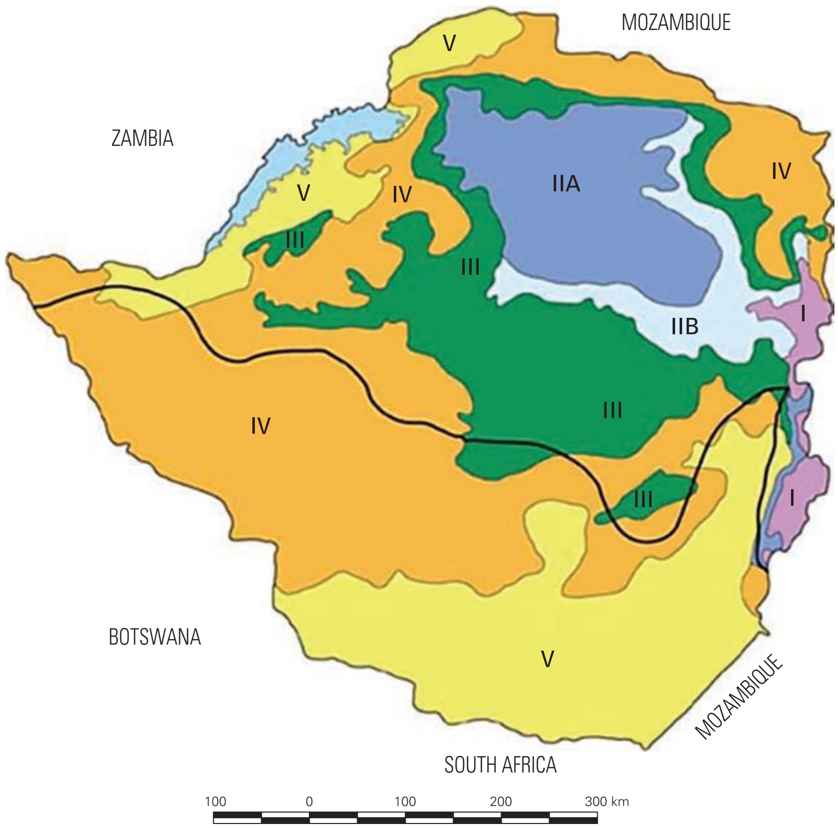
Region II is located in the middle of northern Zimbabwe. Rainfall ranges from 750 millimeters to 1,000 millimeters per year and is fairly reliable, falling from November to March/April. Because of the reliable rainfall and generally good soils, this region is suitable for intensive cropping and livestock production. The cropping systems are based on flue-cured tobacco, maize, cotton, wheat, soybeans, sorghum, groundnuts, seed maize, and burley tobacco grown under dryland conditions as well as with supplementary irrigation in the wet months. Irrigated crops include wheat and barley grown in the colder and drier months (May-September). Region II is suited to intensive livestock production based on pastures and pen-fattening utilizing crop residues and grain. The main livestock production systems include beef, dairy, pig, and poultry systems.

Region III is located mainly in the mid-altitude areas, characterized by annual rainfall of 500–750 millimeters per year, midseason dry spells, and high temperatures. This semi-intensive farming region is suited for livestock production, together with production of fodder crops and cash crops under good farm management. The main crops are maize and cotton, and the region is also suitable for producing groundnuts and sunflowers.

Region IV, located in the low-lying areas in the north and south, has annual rainfall of 450–650 millimeters per year, severe dry spells during the rainy season, and frequent seasonal droughts. Although Region IV is considered unsuitable for dryland cropping, smallholder farmers grow drought-tolerant varieties of maize, sorghum, pearl millet, and finger millet. This region is ideally suited for raising cattle in extensive production systems and for wildlife production.

Region V covers the lowland areas below 900 meters above sea level in the north and south, with highly erratic rainfall that is less than 650 millimeters per year. Although the northern part of Region V along the Zambezi River receives reasonable rainfall, its uneven

Figure 2. Agro-Ecological Regions and Soil Map



topography and poor soils make it unsuitable for crop production. Generally, Region V is suitable for extensive cattle production and game-ranching, and it is also appropriate for forestry and wildlife/tourism.

Although both Regions IV and V are too dry for crop production, households on the communal lands in these regions grow grain crops (maize and millet) for food security and produce some cash crops such as cotton. Crop yields are extremely low, and the risk of crop failure is high (likely to occur in one out of three to five years). Cattle and goat production are major sources of cash income. Most of the communal lands are in the marginal agro-ecological regions. They are characterized by low rainfall (averaging 400–500 millimeters per year), severe dry spells in the rainy season, and shallow soils of low fertility. Such conditions are very marginal for the production of major crops, even drought-resistant grain crops such as sorghum and millet.

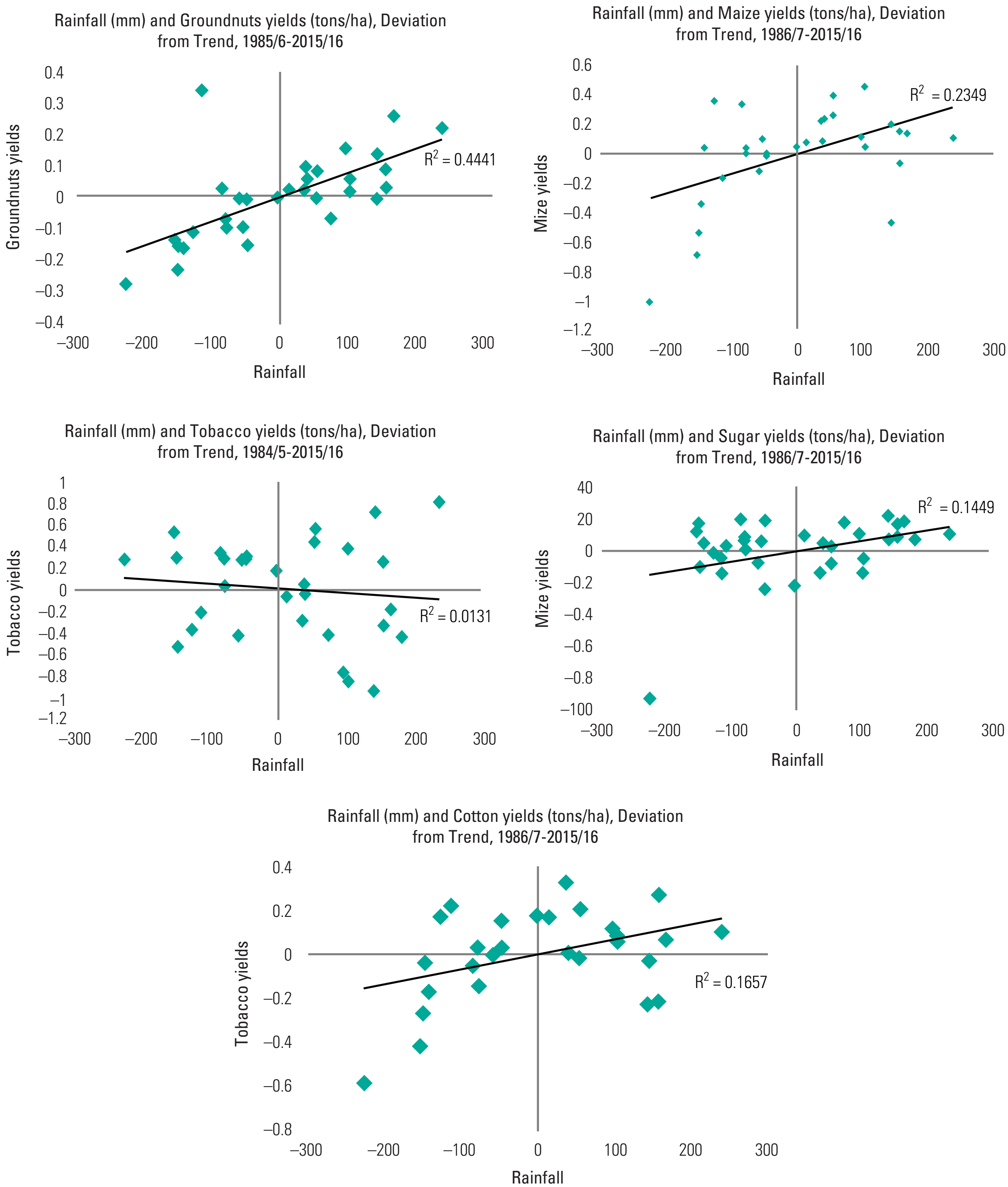
3.2 Risk Identification

This section presents Zimbabwe's exposure to risks for the various crop and livestock commodities introduced in Chapter 1. At the request of the GoZ, this chapter focuses on production risks at the farm level, as there is much interest in using the findings to develop options for more proactive agricultural disaster risk management practices.

The impacts of different types of risks on the different crops and supply chains vary depending on the severity of the event, the risk exposure, and the capacity to manage risk. For instance, the yields of groundnuts and maize show a higher and positive correlation with rainfall, while tobacco, sugarcane, and lint cotton yields have a lower correlation with rainfall (Figure 3). These results indicate that groundnut and maize yields are more highly determined by weather-related factors than yields of tobacco, sugarcane, and cotton.

Tobacco and to a lesser extent sugarcane and cotton producers and their respective supply chains have relatively effective production risk management mechanisms available (such as irrigation, improved seed, and good agricultural practices), mostly because contract farming dominates production of these commodities. In addition, tobacco can be planted early to avoid possible mid-season dry spells, while the opposite occurs with the other crops.

Figure 3. Correlation Between Rainfall and Crop Yields, Zimbabwe



Source: Based on MAMID data.

The risks for the various agricultural supply chains were identified through quantitative analysis, secondary information, and interviews with numerous stakeholders in each commodity supply chain.[4] This chapter summarizes the risk identification exercise for each commodity; for technical details, see Appendix D.

The most important agricultural risk in Zimbabwe is drought. Other weather-related risks are also frequent but have lower and more isolated impacts.[5] Sanitary and phytosanitary risks are common among all crops and livestock; they are usually managed as long as agrochemicals and vaccines are available and farmers have resources to purchase them. Price volatility has also been reported as a risk, and price stabilization policies are perceived to have added more uncertainty to the market.

In general, at a certain manageable degree of intensity the main production risks are only partially prevented or mitigated by familiar risk mitigation practices such as irrigation, diversifying crops, using appropriate inputs, and so on. For infrequent and intense disasters, ideally households should be able to transfer risk to capital markets. The majority of Zimbabwean households, however, apply limited risk mitigation measures and no transfer mechanisms, so they are severely affected when risks materialize. In those cases, farmers tend to absorb the losses through coping strategies such as selling assets (which reduces their disposable income), reducing meals, and pulling children out of school, impacting their wellbeing in the short and long run.

Table 5 summarizes results of the technical exercise detailed in Appendix D to identify production risks by category of stakeholder, as well as the risk management practices currently used by stakeholders.

3.3 Risk Prioritization

This section narrows the list of agricultural production risks presented in Table 5 down to a group of key priority risks that are important at the national level because of their potential to cause agricultural production volatility and food insecurity. To better identify policies and allocate scarce resources for agricultural risk management, the risks identified in Table 5 are prioritized in terms of: (1) their frequency of occurrence; (2) their potential to cause losses; and (3) the capacity of stakeholders to manage the risks. Figure 4 plots the risks that were identified to be a priority based on the probability of occurrence, from highly probable (1 in 3 years) to less probable (1 in 20 years), and their expected impact (from High to Catastrophic levels of losses for the sector). This figure has been adjusted to reflect the capacity to manage risks by stakeholders.

In the figure, the risks plotted in red (weather related) and green (pests and diseases) are production risks, whereas the circles in yellow show market and enabling environment risks. Those risks plotted toward the right-hand side of the figure are the most significant risks in terms of their potential to cause the greatest losses and their lower capacity to be managed by stakeholders or the government. For example, a critical risk, occurring approximately every 5 years, is severe drought with high temperatures in agro-ecological Regions IV and V. This type of drought affects both crops and animals, and because it causes large losses in fragile agro-ecological regions, it is a high priority that requires effective mitigation measures (to be discussed in Chapter 5).

Other noteworthy risks are severe drought with high temperatures, occurring in all regions with a frequency of 1 in 10 years, and prolonged consecutive seasons of under-normal rainfall in sugarcane production areas, occurring approximately every 10 years. Droughts can greatly affect agricultural production and food security. For example, the 2015/16 drought induced by ENSO caused agricultural output to fall by 5 percent in 2016 (World Bank 2017a). An estimated 4 million people were food insecure in 2016. Increasingly frequent and severe droughts in southern and western Zimbabwe are making these areas increasingly unsuitable for rainfed maize production (MAMID/FAO 2017), highlighting the need to reconsider the boundaries and crop suitability patterns established for Zimbabwe's agro-ecological zones 60 years ago.

Other weather-related events (such as prolonged mid-season dry spells, erratic rainfall, and hailstorms), as well as issues related to policy (such as support prices and input provision to farmers), occur with relatively high frequency (1 in 3 years) and can have highly negative impacts, although less so than other risks, on the different stakeholders of most supply chains. Two other risks with highly negative impacts are the uncertain availability of animal draft power (1 in 10 years) and pests (fall armyworm) in maize production, as well as incursions of the *Tuta absoluta* moth in horticulture and tobacco production (1 in 20 years).

Table 5. Production Risks and Current Risk Management Practices by Stakeholder Group, Zimbabwe

Stakeholders	Production risks	Current risk management (mitigation and transfer)
Small-scale maize, groundnut, tobacco, cotton, and cattle producers **and** **Medium- to large-scale maize, tobacco, and cattle producers (A2)**	• Severe droughts and high temperature in Regions IV and V (1 in 5 years), affecting all crops and animals • Severe droughts and high temperature in all regions (1 in 10 years), affecting all crops and animals • Erratic rainfall distribution affecting non-drought-tolerant and non-irrigated crops (e.g., maize, tobacco) • Delayed onset of rains affecting mostly tobacco farmers (1 in 5 years) • Prolonged mid-season dry spells affecting yields of all crops except cotton and tobacco; tobacco is affected mostly in terms of quality (1 in 3 years) • Short rainy season, affecting quality and yields of crops and grazing (1 in 3–5 years) • Floods affecting low-lying areas (1 in 10 years) • Hailstorm for tobacco, which are confined to a limited area but very destructive • Pests and diseases in the field (armyworm for maize and cotton, mealybug for cotton, rust in tobacco, *Tuta absoluta* in tomatoes, acaricide-resistant ticks in cattle, foot and mouth disease), and post-harvest pests and diseases • Introduction of viral Maize Lethal Necrosis Disease, which is currently present in Kenya and South Africa; it can cause very high losses and there is no control with chemicals	• Water harvesting techniques (including digging infiltration pits) for crops • Conservation techniques (including mulching for cotton) and zero tillage for maize • Staggering planting dates to spread the weather risk • Pest and disease control with chemicals in crops and animals is common, including after harvest • Crop rotation to avoid build-up of diseases and pests • Drought-, disease-, and pest-tolerant varieties/breeds • Smallholder irrigation, mostly for maize (few) and about 30% of medium- and large-scale farmers have irrigation facilities • Vaccination against anthrax, foot and mouth, and black leg • Fire guards in large-scale farms • Insurance against hailstorms and drought in tobacco, required for contract farming
Medium- to large-scale farmers growing wheat under irrigation (A2)	• Severe droughts (1 in 10 years), affecting availability of irrigation water • Early onset of rains • Pests and diseases	• Irrigation • Early-maturing varieties • Chemical applications • Fire guards
Medium- to large-scale (A2) sugarcane farmers **and** **Sugar estates**	• Severe droughts (1 in 10 years) • Prolonged consecutive seasons of under-normal rainfall (1 in 3–5 years) • Pests and diseases (yellow sugar, *Eldana saccharina*) • Black maize beetle, affecting A2 farmers	• Drilling boreholes to supplement surface irrigation water • Insurance • Fire guards • Drought-, disease-, and pest-tolerant varieties • Chemical control of pests and diseases • Rotational use of pesticides and insecticides • Biological control of pests • Guarding fields to protect against theft and wildlife • Buy electricity generators
Small-, medium-, and large-scale horticultural crop producers	• Severe droughts (1 in 10 years) affect production of all horticultural products • Prolonged mid-season dry spells affecting yields (1 in 3 years) • Frost • Excess rainfall increases incidence of fungal diseases	• Very exposed
Commercial poultry producers	• Disease outbreak (Newcastle, avian influenza)	• Farmers tend to grow own maize and soybeans as a complement • Buy electricity generators
Maize and wheat millers	• Drop in the supply of raw material	• Very exposed

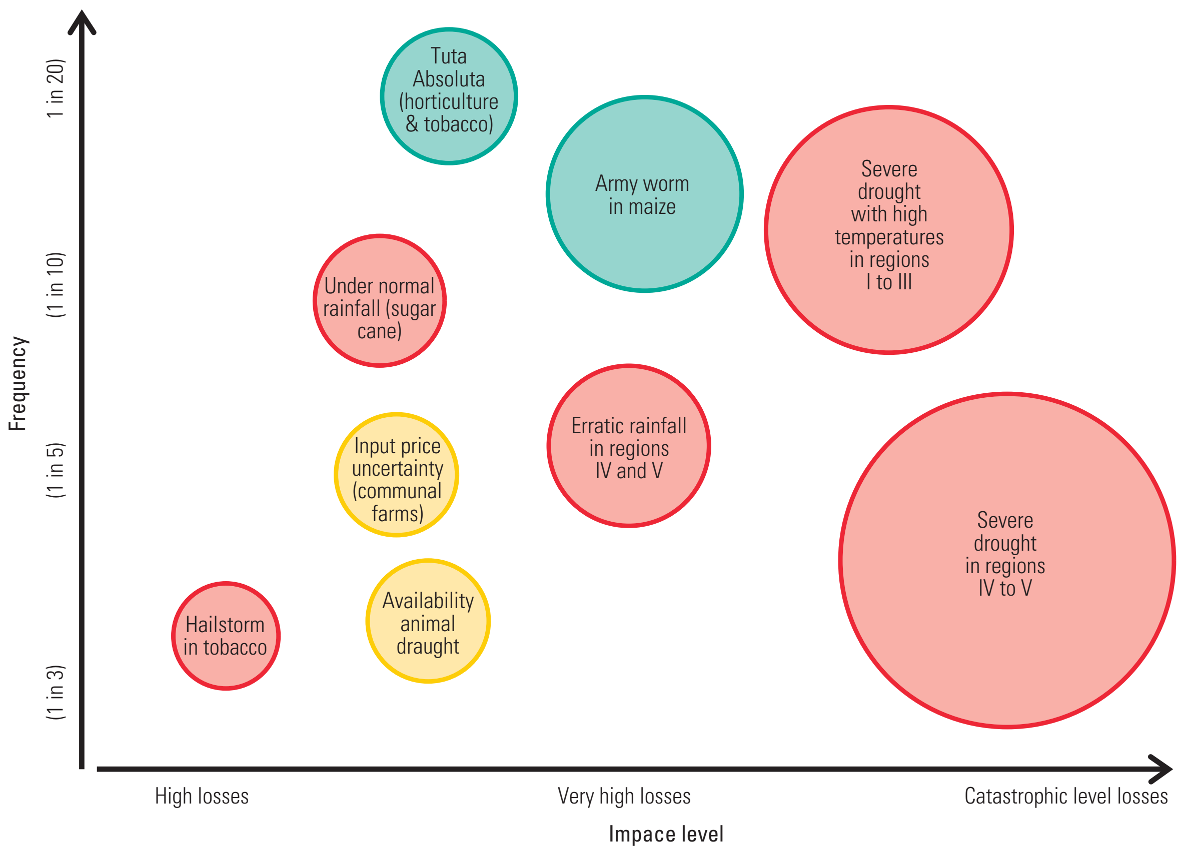
(Table continues next page)

Table 5. *(continued)*

Stakeholders	Production risks	Current risk management (mitigation and transfer)
Tobacco traders	• Drop in the supply of raw material	• Contract farming to secure supplies
Horticultural processors and traders	• Drop in the supply of raw material	• Contract farming to secure supplies • Own electricity generators
Abattoirs	• Drop in the supply of raw material	• Keep some herds to supplement feeding and meet their customers' quality requirements • Own electricity generators
Dairy processors	• Drop in the supply of raw material	• Contract farming to secure supplies
Input suppliers	• Availability of maize and soybeans as main feed ingredients, which could become scarce because of drought	• Contract farming to secure supply of animal feed

Source: This table presents findings from field research with stakeholders, plus information obtained from the periodic reports of public and private sector agencies, and from informed opinion of experts.

Figure 4. Prioritized Agricultural Risks, Zimbabwe



Note: Production risks are plotted in red (weather related) and green (pests and diseases); market and enabling environment risks are in yellow.

In conclusion, agricultural production and market risks are more likely to impact smallholder farmers in Regions IV and V than to impact smallholders in other agro-ecological regions, and poor soils and deforestation are increasing the vulnerability of farmers in Regions IV and V. The group that is most exposed to production and market risks is poor farmers, especially farm households headed by women and children. Not only are they more exposed to risks, but their initial vulnerability is higher and they have a lower capacity to manage agricultural risks. In sum, managing a great portion of agricultural risks in Zimbabwe will require that special attention is given to building a resilient, diversified agriculture for smallholder farmers in these highly risk exposed areas.

Notes

1. The findings are in line with the World Bank (2016a) methodology for systematically assessing and prioritizing agricultural risk at the sector level.
2. Based on FAO (2006), but note that the GoZ is redrawing the agro-ecological zones to better reflect current conditions.
3. Most crops are planted in November/December at the beginning of the rains and harvested between April and June. Winter wheat, barley, and various horticultural products are grown in the dry season under irrigation. Irrigation schemes are also important in supplementing the production of wheat, tobacco, maize, cotton, soybeans, groundnuts, and coffee.
4. Results were presented at a technical workshop in Zimbabwe on May 7, 2018 to validate the interpretation.
5. With the exception of the most recent incursion of fall armyworm.

Chapter 4

CAPACITY TO MANAGE AGRICULTURAL RISK

The design of agricultural risk management strategies takes into account the frequency of risk events as well as the potential to cause losses, as seen in previous chapters. It is equally important to assess the capacity of stakeholders at various levels, from smallholder farmers to other participants along the supply chains, to manage the risks to which they are exposed. To a great extent, the management of agricultural risk in Zimbabwe will depend on the capacity of smallholders, who dominate agricultural production, to reduce and curtail risk at the farm level through risk reduction strategies such as those identified during the field assessment and described in Chapter 3. Yet as the field assessment has shown, smallholders have limited ability to reduce and curtail agricultural risks. In this context, the public sector can play an important role in supporting the agricultural sector by (1) assisting farmers in strengthening their resilience at the farm level and (2) by providing timely disaster response support after high-impact events. The capacity of the public sector to provide the necessary support appears weak, however.

This chapter starts by describing some of the factors that make Zimbabwe's rural households and farmers vulnerable to natural disasters. It then outlines the public sector's role in managing agricultural risks and capacity to do so, focusing first on public agricultural services for strengthening the resilience of smallholder farmers and second on a diagnosis of public sector capacity to respond to natural disasters. The findings inform the suggestions for designing an agricultural risk management strategy, presented in Chapter 5.

4.1 Vulnerability Factors

High levels of poverty, gender asymmetries, lack of assets, and absence of mechanisms to absorb income shocks all expose the rural population to agricultural risks. That exposure leads to further vulnerability and negative impacts on livelihoods when agricultural risks rise to catastrophic levels. [1]

4.1.1 Poverty

Over 70 percent of Zimbabweans live in rural areas, and about 67 percent rely on agriculture for their livelihoods. Poverty is very high in rural areas, where more than 72 percent of households live in chronic poverty (in comparison, in 2015 poverty rates were 37.2 percent in Bulawayo and 36.4 percent in Harare). The incidence of poverty varies by province and district. Poverty is more prevalent in drier regions (agro-ecological Regions IV and V). For example, the poverty atlas in 2015 indicated that poverty was highest in Matebeleland North (a dry region), with a Gini coefficient of 85.7 percent in 2015. A 2003 poverty assessment found that the incidence of poverty was higher among female-headed households (around 72 percent) than male-headed households (58 percent).[2]

Agricultural risks exacerbate existing poverty traps and cause volatility in agricultural and economic growth. Crop failure caused by droughts and pests is often the biggest shock faced by rural households and may also represent the biggest poverty trap. Agricultural risks have a profound impact on poverty, as they undermine rural entrepreneurs' (particularly producers') possibilities to accumulate assets, invest in and develop their businesses, and gain access to health and education services.

4.1.2 Gender Asymmetries

Important gender asymmetries in asset ownership and access to services leave women farmers more exposed to risks compared to male farmers, and render them less able to mitigate the risks or cope with them as they occur. In Zimbabwe, women constitute 54 percent of agricultural labor force, but men have better access to land than women. Currently, 18 percent of A1 farmers and 12 percent of A2 farmers are female farmers; collectively they have access to 10 percent of the land redistributed under the Fast Track Land Reform.[3] Women own 1,900 of the 18,000 farms in the A2 zone. In the commercial farming sector, 80 percent of cattle are owned by men and 20 percent by woman, while on communal farms only 35 percent of cattle are owned by women.

Land and cattle are critical assets; ownership of these assets is fundamental for individuals seeking credit to develop an enterprise, since they are used as collateral. Access to credit is a constraint for all farmers, but only 2 percent of women farmers in communal lands have obtained credit compared to 9.6 percent of men. Access to financing is directly linked to the use of agricultural inputs and the mechanization of production and processing. Suitable farm machinery is needed to reduce the labor burden in smallholder agriculture, especially the labor burden of women farmers. Women's restricted access to land makes them more vulnerable to poverty, as they have no influence over the land assets and are deprived of the water and other natural resources associated with access to land.

4.1.3 Limited Income Buffers

Livestock often serve as an income buffer for farmers, helping them to obtain additional resources in times of need. When a natural disaster strikes, however, farmers often have to sell their livestock at lower than average prices, bringing little relief. As an alternative, many countries are developing agricultural insurance products and extending them to small-scale producers to help them manage agricultural risks, but such products are limited in Zimbabwe.

4.2 Agricultural Services for Strengthening Resilience

Given the prevailing agricultural risks and considerable vulnerability of the rural population to those risks (especially female- and child-headed households in Regions IV and V), the public sector plays an important role in promoting the development of innovations to increase resilience to disasters, engage in the distribution of those innovations, and train small-scale producers to use best agricultural practices. It is also important for the public sector to develop mechanisms that can rapidly control the spread of pests and diseases. In other words, the agricultural innovation and (phyto)sanitary systems will be especially crucial elements of public sector efforts to reduce small-scale producers' vulnerability to agricultural risks.

4.2.1 Agricultural Innovation System

The public agricultural innovation system (AIS) in Zimbabwe includes the Department of Research and Specialist Services (DR-SS), which is responsible for providing research goods; the Agricultural Technical and Extension Services (AGRITEX), charged with providing extension services; agricultural education for technical training; and the Agricultural Research Council, whose role is to prioritize and coordinate agricultural research countrywide. Aside from these public research and development (R&D) services, the AIS includes the research programs in academia and the private sector, especially crop breeding research by seed companies. Some of the larger seed companies do their own variety development and agronomy research. The largest is Seed Co, a Zimbabwe-based company with a presence in more than 10 African countries. Many of the seed companies use genetic material provide by the International Maize and Wheat Improvement Center (CIMMYT) in their breeding programs. CIMMYT research includes work on drought-resistant maize varieties and climate-smart maize production systems for smallholders.

Government agricultural research spending has increased substantially after the multicurrency regime was implemented in 2009–11, reaching US$43.4 million. Even so, this level of expenditure is low compared to public sector support for agriculture in other countries in the region. Agricultural research spending represents 1.4 percent of GDP in

Zimbabwe, compared to 3.1 percent in Namibia and 2.9 percent in Botswana.

In terms of human resources, Zimbabwe has 208 full-time equivalent public sector researchers, 58 percent of whom have graduate degrees. The public extension service (AGRITEX) has about 1,900 extension workers to serve the country's approximately two million small-scale farmers (one extension worker for every 1,053 farmers). Irrigated areas have a dedicated extension staff (about 150). The challenge of effectively reaching the multitude of farmers is daunting, especially given the limited mobility of AGRITEX staff. The relationship between researches at DR-SS with extension at AGRITEX is also poor due to the limited mobility of AGRITEX staff and overall resource constraints. Resources provided by GoZ to the public sector AIS are used mainly for salaries versus research or extension operations.

Ideally, the public AIS would play a key role in strengthening the resilience of small-scale producers, because they have the least capacity to manage risk and adapt to changes in climate over time. Three priorities for the public advisory services emerged during this assessment: (1) the need for staff to receive technical training in new skills, such as information and communication technology (ICT) and the use of value chain approaches, among others; (2) the need to improve the mobility of extension staff so that they can reach farmers in their area; and (3) the need to digitalize services (for example, digital media can enable advisory services to reach more farmers more effectively and can also provide early warning information more rapidly). Similar restrictions exist with regard to the public research system: (1) its human resources and infrastructure are severely limited, and (2) its staff need training in research on climate-smart agriculture, inter-disciplinary research, socioeconomic and gender research, facilitating innovation platforms, and other areas. Finally, a major challenge is to better integrate support for agricultural research, extension, and education.

4.2.2 Sanitary And Phytosanitary System

The Plant Quarantine Service (PQS) is the national plant protection organization for Zimbabwe, charged with implementing official plant health controls. Other institutions involved with plant health and crop protection operate under DR-SS: the Horticultural Research Institute, the Central Service Research Institute, the Seed Service, and the Plant Protection Research Institute based in the Plant Quarantine Station in Mazowe. PQS is responsible for both the internal and international plant quarantine regimes. It is also responsible for certifying plants and plant products for export and issuing the corresponding phytosanitary certificates. It coordinates plant health and laboratory services and inspections of seed crops, nurseries, warehouses, and other facilities. PQS staff are based in the plant health offices and points of entry across the regions of Zimbabwe and are charged with both inland inspections and inspections of imports. Inspections of cut flowers, fruits, and vegetables immediately prior to export are performed by inspectors based at the Plant Inspection Unit in the cargo area of Harare Airport (EC 2011).[4]

The central animal health institution is the Department of Livestock and Veterinary Services. The main animal health issues involve straying animals, illegal movement of animals, spread of animal diseases, and poor veterinary care.

The European Union (EU) has audited Zimbabwe's sanitary and phytosanitary (SPS) system and the Food and Agriculture Organization (FAO) of the United Nations (UN) has supported capacity building in SPS services. Both the EU and FAO concur in their general observation that the systems (regulatory and relevant instruments) are in place for seed, plant, and animal health, but their implementation is limited by the lack of human resource capacity and analytical infrastructure.

Food safety in Zimbabwe is covered by the Food and Food Safety Standards Act and the Public Health Act. Responsibility for assuring food safety is shared between several institutions and departments, led by the Ministry of Health and Child Care. Other agencies include local authorities and several entities in MAMID. For dairy, the Dairy Act delegates the authority to conduct food safety inspection to the Ministry of Health. Local authorities have by-laws to ensure food safety. They collaborate with the key ministries (Codex Alimentarius, 2016).[5]

4.3 Assessing Disaster Risk Management Capacity

In addition to investing in public sector risk reduction activities through the public AIS and SPS systems, the GoZ has a role in supporting communities affected by disasters through various response and recovery interventions. Legal and institutional frameworks are crucial to provide timely assistance to respond to disasters. The following sections assess the disaster response frameworks in place in Zimbabwe and the capacity to provide effective risk response support.

4.3.1 Legal Framework

Legislation approved in Zimbabwe during the last two decades defines the responsibilities and regulates the activities of the public sector in relation to disaster risk management (Table 6). Most notably the Civil Protection Act (1989) sets forth the current legal basis for organizing, coordinating, and planning the response to natural disasters and emergencies occurring in Zimbabwe. The act contains provisions establishing the Department of Civil Protection (DCP) in the Ministry of Local Government, Public Works and National Housing and establishing the National Civil Protection Fund to finance civil protection activities in the event of a disaster. Given the recognized shortcomings of this act—which provides only for civil protection and emergency management rather than for a more holistic approach that includes disaster risk reduction, preparedness, and risk financing—it is to be replaced by a Disaster Risk Management Bill (2011), still under discussion in Parliament.

A recent review by the UN (CADRI 2017) reports that although the Disaster Risk Management Bill is not aligned with the Sendai Framework for Disaster Risk Reduction, the bill as it stands provides a reasonable level of detail and covers most aspects that would normally be incorporated in a legislative document of this kind. The review adds that the 2011 bill as it stands is associated with significant costs, particularly the requirement that a minimum of 1 percent of the national budget must be appropriated to address disaster risk management. Due to the financial constraints presently facing Zimbabwe, the report suggests that this commitment may need to be amended to reflect a desired end-state, with flexibility to work toward the 1 percent financing goal as finances allow.

Two additional pieces of legislation related to the disaster risk management system are presented in Table 7. The institutions established through this additional legislation have some limitations that are relevant to this disaster risk assessment, especially considering that weather-based disasters are the most common types of disaster in Zimbabwe. For example, although the Meteorological Services Act (1990) sets up a meteorological services fund that enables the Meteorological Department to fulfill its functions of forecasting and supporting the management of weather-based disasters, the fund is set up only to finance the services of the department and does not serve as a contingency fund for emergencies. Also, although the Grain Marketing Act (1996) provides guidelines to ensure that the GoZ has reserves of around 500,000 metric tons of grain to be used during emergencies, the Grain Marketing Board (GMB) faces challenges in meeting this requirement owing to the recent low grain production levels in Zimbabwe.

Table 6. Basic Legislation for Disaster Risk Management

Legislation	Key provisions
Civil Protection Act 10.06 (1989)	Legislates for the coordination of preparedness planning for emergencies and disasters. Provisions include the establishment of national, provincial, and district civil protection committees, made up by existing government, civil society, non-governmental, and United Nations organizations. The act establishes civil protection organizations and provides for the operation of civil protection services in times of disaster.
	The act explicitly states that the Head of State is the only individual who can declare a state of disaster in the country after receiving recommendations from the responsible minister. This arrangement may delay the declaration of a state of disaster and thus delay the mobilization of funds and other types of support.
The Disaster Risk Management (DRM) Bill (2011)	This bill, if approved by the legislature, will update and supersede the Civil Protection Act. It provides more elaborate mechanisms for disaster risk reduction and addresses structural and organizational gaps in the Civil Protection Act. It emphasizes localized decision-making in which local authorities take a leading role in disaster preparedness and response.
	The draft DRM Bill requires a minimum of 1 percent of the national budget to be appropriated to address disaster risk management (Government of Zimbabwe 2011). Additionally, the bill proposes a disaster risk management levy: "The Minister of Agriculture, in consultation with the Working Party and with the approval of the Minister for the time being responsible for Finance, may by notice in a statutory instrument, impose a Disaster Risk Management Levy on any person or class of persons whose activities are a potential hazard that include buildings, roads (tollgate fees), insurance, fire, fuel, carbon tax and tourism."

Table 7. Additional Legislation Supporting Disaster Risk Management

Legislation related to disaster risk management	Key provisions
Meteorological Services Act (1990)	This act establishes the administration, functions, and powers of the Meteorological Department in the Ministry of Environment, Water and Climate. The department's functions include collecting and disseminating meteorological data, issuing weather and climate forecasts and advance warnings on weather conditions, and carrying out meteorological research and investigations.
Grain Marketing Act (1966)	This act establishes the Grain Marketing Board (GMB) under the Ministry of Agriculture and prescribes its powers, functions, and duties. The main responsibility of the GMB is to regulate and control prices and marketing of agricultural products and their derivatives that are sensitive to food security. The GMB also establishes and administers a trading reserve fund for each controlled product, and if at the close of the financial year a controlled product has a surplus, it is transferred to the reserve fund. The GMB maintains a strategic grain reserve.

4.3.2 Policy Framework

Table 8 summarizes the key policies and strategies that support disaster risk management and financing. The National Climate Policy and National Climate Change Response Strategy (NCCRS) provide an opportunity to integrate climate change and climate risk management policy (CADRI 2017). The National Climate Policy (2016) calls on government to establish a National Climate Fund (NCF) that is supported by an annual allocation from the national budget to finance the climate strategies and implement the Climate Policy. If established, the NCF could be used for disaster risk financing, given that Zimbabwe is susceptible to climate-related disasters, particularly droughts and floods. The NCCRS provides a comprehensive and strategic approach to disaster risk management through its first pillar, which focuses on Adaptation and Disaster Risk Management. The NCCRS proposes that $519 million be allocated for disaster risk management and human settlement; potential sources of financing are the government, development partners, private sector, and local, regional, and multilateral banks. Yet as shown in Table 8, many of the policies and strategies make few or no provisions to address disaster risk financing.

Table 8. Policy and Strategies Related to Disaster Risk Management and Financing

Policy/strategy	Key provisions
National Climate Policy (2016)	The policy seeks to reduce vulnerability to climate change and variability and strengthen adaptive capacity in key economic sectors such as health, water, agriculture, forestry, and biodiversity. It commits the government to ensure that mitigation and adaptation measures enhance agriculture-based livelihoods, by promoting food security and poverty alleviation. It also commits the government to strengthen the infrastructural capacity of the National Meteorological and Hydrological Services and Climate Change Management Departments to carry out research on climate change through improved data collection and management, and climate modeling. It looks at the establishment of a National Climate Fund, which is supported by a 10 percent budgetary allocation, to finance climate-related activities and programs.
National Climate Change Response Strategy (NCCRS) (2015)	The NCCRS has specific provisions for dealing with climate change issues, understanding the extent of the threat, and putting in place specific actions to manage potential impacts. Financial resources will be allocated by the national treasury, private sector, green climate funds, bilateral donors, and international agencies.
Zimbabwe National Contingency Plan	This contingency plan, developed through a contingency planning workshop, presents a hazard profile of the country and prioritizes the key hazards that are likely to require contingency measures. The purpose of the plan is to inform the disaster preparedness processes of the government and civil society.
Disaster Risk Management Strategic Plan 2016–2020	This strategic disaster risk management plan looks at the institutional capacity of the National Civil Protection Committee to mitigate, prepare for, respond to, and help the country recover from disasters. It identifies financing gaps in performing these functions and opportunities for addressing them.
National Policy and Programme for Drought Mitigation	This policy recognizes the effects of drought on rural communities and encourages strategies that aid communities in adapting to climate change. These strategies encompass early planting, choosing drought-tolerant and early-maturing varieties, adopting water conservation measures, and cross-breeding and selling livestock.

For example, the DCP Strategic Plan for 2015–2020 makes no mention of disaster risk financing or strategies for financing. The draft National Disaster Risk Management Strategy of 2012 only mentions the creation of a localized "disaster fund" to enhance resilience to disasters at all administrative levels in the country.

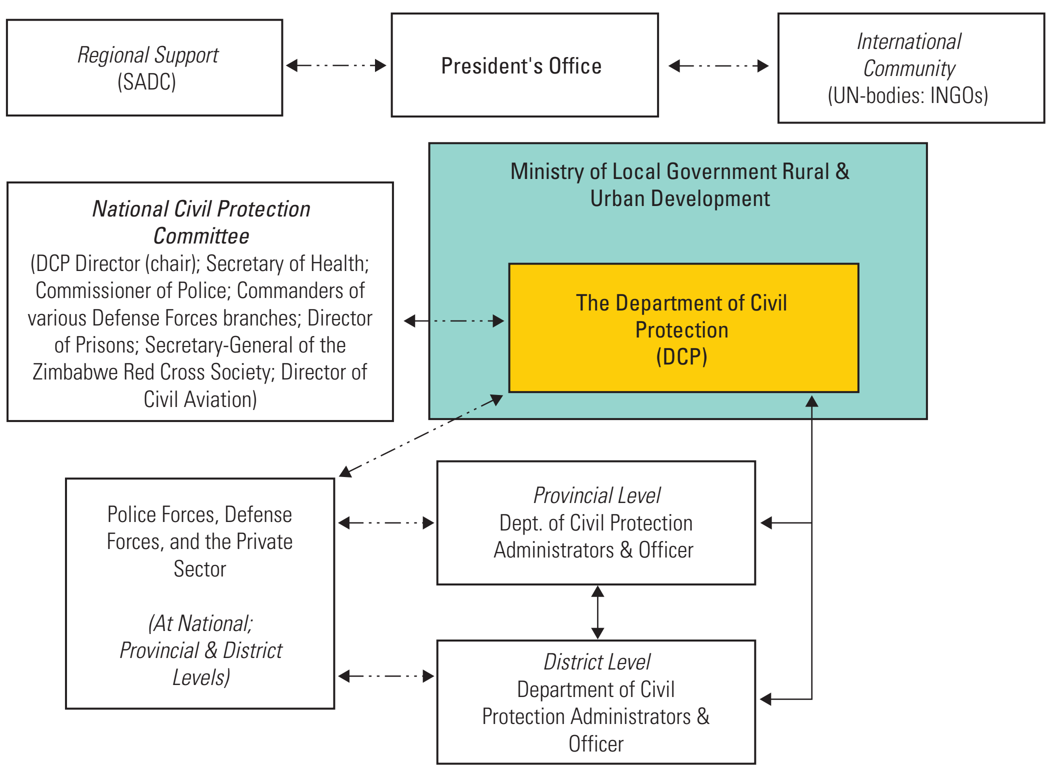
In sum, even though the existing and proposed policies and legislation regulating disaster risk management in Zimbabwe mention potential sources of funds for risk financing, the missing piece is the design of a clear disaster risk financing strategy. This strategy should identify the sources of contingency financing for emergencies, define various financing layers and instruments to meet the requirements for disasters with different levels of severity, establish the rules for triggering the use of each source of finance, and determine the channels through which resources will reach beneficiaries in times of crisis—from early warning systems and preparedness to the implementation of recovery programs, including support for rehabilitating small-scale production and restoring food security. Public financing sources to respond to disasters will be reviewed in detail in the next chapter.

4.3.3 Institutional Framework and Coordination

Figure 5 depicts the structure of Zimbabwe's emergency management system. The DCP, the center for coordinating all disaster management activities, works through a national, multisectoral platform—the Civil Protection Organization (CPO)—which provides for the operation of civil protection services when disasters occur. The CPO platform is made up of civil protection committees with multisectoral representation from government ministries and departments, parastatals, donor partners, non-governmental organizations (NGOs), and co-opted members from the private sector (Ministry of Local Government 2009). The role of this platform is to provide advice and coordination related to national disaster risk efforts as well as to make recommendations to the DCP on risk reduction.

Institutional systems for disaster risk management in the country currently comprise the following basic structures: the National Civil Protection Committee, DCP, Food and Nutrition Council (FNC), and Zimbabwe Vulnerability Assessment Committee (ZimVAC). Other participating structures

Figure 5. Structure of Zimbabwe's Emergency Management System



Source: Chikoto and Sadiq 2013.

are the Provincial Civil Protection Committee, District Civil Protection Committee, Emergency Services Subcommittee, National Food and Water Subcommittee, National Epidemics and Zoonotic Crisis Subcommittee, and National Resource Mobilization Subcommittee (CADRI 2017).

These Civil Protection Committees are grouped into four functional subcommittees: Food Supply and Security; Health, Nutrition, and Welfare; Search, Rescue, and Security; and International Cooperation Assistance (Ministry of Local Government 2009). The DCP and its substructures have been affected by staff turnover and the government policy of not replacing departing staff, so they have insufficient resources to respond effectively to national disasters.

The DCP coordinates the National Civil Protection Coordination Committee (NCPCC), which derives its mandate from section (41) (2) of the Civil Protection Act and is responsible for the execution of civil protection functions. The National Civil Protection Plan provides the overall framework for promoting, coordinating, and executing emergency and disaster management in Zimbabwe. It contains guidelines for planning, executing, and preserving civil protection systems and functions in Zimbabwe (Ministry of Local Government 2009). Decentralization of the DCP structures to the district level and cross-sector participation are positive traits for the NCPCC.

The lean structure of the DCP makes it difficult for the DCP to effectively coordinate disaster risk management in the country. The DCP does not have an emergency operations center that can be activated in the event of a disaster. Moreover, CADRI (2017) has reported that the multisectoral stakeholder platform does not necessarily comprise individuals with expert knowledge in disaster risk management, which results in poor or slow decision making. In general, the disaster risk management system predominantly focuses on responding to natural disasters after they occur and on financing emergency relief activities from the annual government budget and international humanitarian assistance.

The disaster response and preparedness of the DCP is informed by the Meteorological Services Department, which systematically observes and monitors hydro-meteorological parameters for hazard forecasts and near-real-time data for early warnings to support emergency preparedness and response. The use of radar enables the department to release short-term (10-day) weather forecasts, which make it possible to monitor extremes such as heavy rainfall and heat waves. The Meteorological Services Department also produces medium-term forecasts to develop weather advisories for agriculture, disaster risk management, and water resources. The effectiveness of Zimbabwe's Meteorological Services Department and its satellite offices at the district level for early warning is largely constrained by inadequate funding, the failure to upgrade and manage equipment (especially at local stations), and staff turnover.

In the agricultural sector, the Ministry of Lands, Agriculture, Climate, Water and Rural Resettlement (MLACWRR) and the FNC are also key institutions that play a role in disaster risk management and financing. MLACWRR is the custodian of the overall policy governing agricultural production in Zimbabwe. It is the arm of the GoZ mandated to provide technical, extension, advisory, regulatory, and administrative services to the agricultural sector to achieve food security and economic development. The extension officers play a key role in preparing communities for an impending disaster and advising them in the event that it occurs. The FNC, under the Office of the President and Cabinet (OPC), works closely with Meteorological Department and the MLACWRR to oversee drought management and response. The FNC chairs and utilizes ZimVAC as an early warning tool for monitoring food security at the household level in both rural and urban areas. ZimVAC assessments provide hazard information that helps to identify actual or impending external shocks that may affect livelihood systems. Hazard information details traditional early warning data such as weather, crop production, price and market information, and other shock indicators. This set of information is essential for understanding the nature and magnitude of a climatic shock and the specific expression of this shock in a geographical setting at the provincial and district levels, which then enables early action and disaster risk preparedness by institutions such as the Civil Protection Unit.

4.3.4 Disaster Financing Mechanisms

This section reviews the effectiveness, gaps, and weaknesses of existing risk financing strategies. This review forms the basis for the recommendations presented in the next chapter on how to strengthen the disaster response and risk financing systems in Zimbabwe's agricultural sector. This analysis is in line with the current approach adopted to strengthen

Table 9. Allocations from the Ministry of Finance and Economic Development Contingency Fund to the Department of Civil Protection for Disaster Operations

Year	Allocations from Treasury to DCP (US$)
2012	1,000,000
2013	Not available
2014	450,000
2015	300,000
2016	300,000
2017	354,000
2018	1,220,000

Source: DCP.

financial resilience developed by the Global Facility for Disaster Reduction and Recovery.[6]

To finance disaster response, the Ministry of Finance and Economic Development (MoFED) uses mostly ex-post financing options through budget reallocation and debt rescheduling arrangements and ex-ante financing through budget reserves and contingency funds. To channel resources to the affected population, the DCP requests funds from the MoFED contingency fund; the fund is replenished annually with US$35 million (DCP 2018) for extraordinary budget requests, which could include disaster response funding. Table 9 shows the disaster fund allocations made by MoFED to the DCP from 2012 to 2018.

The DCP's operational budget is very low and not sufficient to meet its operational mandate effectively. In 2017, MoFED allocated an annual operational budget of US$286,000 (representing 0.004 percent of the Ministry of Local Government's allocated budget) (Government of Zimbabwe 2017c).

The National Civil Protection Fund, which is administered by the DCP and receives financing from both MoFED and the public, is an important instrument for disaster risk response financing, given the limited budget allocated to DCP. The amount allocated to the fund varies annually. Table 10 shows the breakdown of disaster risk related programs that were funded by the Treasury through the Civil Protection Fund from 2009 until 2016.

The fund caters for all civil protection operations, including disaster events, throughout the country's 59 districts and 1,200 wards, and is generally considered insufficient. The absence of reserved funds at the provincial and district level places a lot of pressure on the Civil Protection Fund and is a huge setback to efforts to reduce disaster risks in the country. Most local authorities are expected to react to disasters first, before requesting external assistance, but these institutions are incapacitated financially and in turn rely on the DCP or donors and civil society for funding. Local authorities' budgets are separate from the central government budget and consist of local revenue derived primarily from sales, fees, fines, permits, property rates, and licenses. If local authorities estimate that their current budgets are insufficient, the Ministry of Local Government, Public Works and National Housing issues "borrowing limits," which are calculated depending on the population of the specific district. When a disaster occurs at the urban level, the urban council is responsible for disaster response. A review by the World Bank (2016) shows that total debt across all local urban authorities in Zimbabwe had reached $555 million, however, representing 105 percent of all revenue collected by local authorities.[7] Consequently, local authorities that do not have sufficient revenue to finance disasters submit requests for assistance to the DCP, which can make use of the Civil Protection Fund or request additional funds from MoFED.

One of the challenges cited by the DCP in relation to accessing finance from MoFED is generally the lag between the time the ministry announces its

Table 10. Budget Allocations (In US$) from the Civil Protection Fund

Disbursed	Food and Nutrition Council	Harmonized cash transfers	Food deficit mitigation	Animal diseases and risk management
2009	33,500	1,165,851	3,000	3,348,839
2010	171,000	1,418,692	4,250,000	4,164,087
2011	360,000	1,473,657	1,350,000	4,987,779
2012	510,000	350,000	230,000	2,568,232
2013	4,669,801	900,000	—	1,839,526
2014	240,000	370,000	—	572,506
2015	365,963	1,652,000	274,000	904,322
2016	767,000	3,762,000	3,784,273	685,444
Average	***889,658***	***1,386,525***	***1,236,409***	***2,383,842***

Source: DCP.

budget allocation to the department and the actual time that DCP receives the funds. In some instances, the total allocation may take as long as six months to arrive, because it is provided in installments, which limits the DCP's ability to respond to a disaster in a timely, adequate manner. For example, the DCP indicated that it could not respond quickly to the 2017 flooding in Tsholotsho District because the resources for disaster management had not yet been allocated from MoFED. The DCP then used resources from other lines in its budget, which were not enough to respond the disaster. In line with the provisions of the Civil Protection Act, the private sector (in this case the Bankers Association of Zimbabwe), which was approached for assistance, donated money toward disaster relief. Moreover, the weak financial capacity of the DCP curbs its ability to provide follow-up funds once the disaster has passed.

As indicated in Table 7, the Grain Marketing Act (1966) established the GMB as a parastatal with a commercial and social role. The Grain Marketing Act requires the GMB to hold a Strategic Grain Reserve (SGR) of 936,000 tons of maize and other grains to meet food security needs and act as a buffer during food emergencies, including critical periods when drought can occur. Of that amount, 500,000 tons must be held as physical stocks and the remaining 436,000 tons must be backed by the equivalent cash reserve (World Bank 2017). The GMB is mandated to procure grain for the reserve from domestic sources and across the Southern Africa Development Community region. Zimbabwe requires 1.5 million metric tons of cereal grain for human consumption to be self-sufficient (ZimVAC 2016). At the current procurement price of US$390 per ton of maize, the GMB has to hold grain stocks worth about US$195 million.

The GMB can sell grain commercially, and during the lean season it generally provides grain for government food assistance programs in collaboration with the Ministry of Social Welfare. As noted, however, the GMB faces challenges in meeting the targeted volume of grain reserves due to the recent low production levels experienced in Zimbabwe. Structural constraints (such as limitations on farmers' access to inputs, the lack of credit facilities, and challenges in accessing cash), aggravated by the impact of droughts and floods, have contributed to the decline in national production capacity (CADRI 2017). Two sets of crop assessments conducted bi-annually are used to project crop output and determine whether grain must be imported or exported as well as the amount needed for the SGR. Table 11 shows maize imports and their value between 2015 and 2018.

Resources from the SGR are released only when the president declares a national disaster. Such a declaration is often made when the crisis has already occurred, as in the 1991/92 and 2015/16 droughts. In the case of the 1991/92 drought, the government had already sold its SGR and had to appeal for humanitarian aid, but by then most parts of the country were already experiencing chronic food insecurity. The slow response to the early warning by decision makers affects the effectiveness of the SGR as a disaster risk financing measure in the case of a drought. The DCP has noted that in terms of disaster risk financing, the SGR is housed inside the GMB, and no structures are in place to differentiate it from the GMB.

4.3.5 Ex-Post Disaster Risk Financing from Donor and Humanitarian Aid

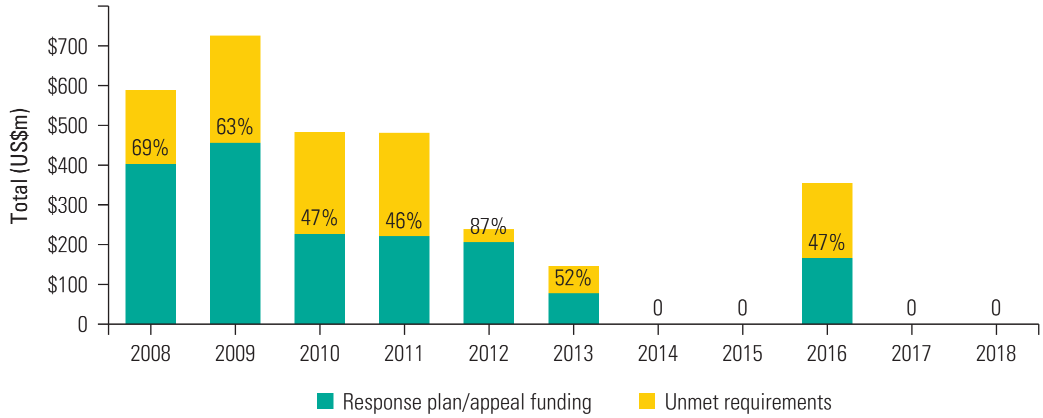
When a disaster exceeds the national capacity to respond, national authorities request international assistance. Humanitarian aid organizations, Zimbabwe's development partners, and NGOs mobilize disaster response resources from different sources. For example, humanitarian organizations can access funding for life-saving activities from pooled funds that can disburse resources quickly but that have limited resources. Key humanitarian and development partners involved in providing disaster response assistance in Zimbabwe include the World Food Programme of the UN, UNICEF, FAO, the Department for International Development of the United Kingdom, and the United States Agency for International Development (USAID), including through major support of the United Nations Development Programme's (UNDP's) Zimbabwe Resilience Building Fund crisis modifier mechanism, the EU, Swedish International Development Agency, Japan International Cooperation Agency, and civil society organizations. Another resource that has been used in Zimbabwe is the Central Emergency Response Fund (CERF) under the UN.

Table 11. Maize Imports and Their Value, 2015–18

Year	Metric tons	Value (at US$390/t)
2015–2016	49,689.91	19,379,064.51
2016–2017	447,229.63	174,414,554.14
2017–2018	128,971.00	50,298,691.17
Total	***625,890.538***	***244,097,309.82***

Source: MOFED (Dzenga and Nyaruwanga, personal communication).

Figure 6. Zimbabwe Humanitarian Response Plan, 2008–16



Source: OCHA Financial Tracking Service, https://fts.unocha.org/appeals/519/summary, accessed September 2018.

The CERF tends to be one of the first ports of call for small grants not exceeding US$250,000 for projects implemented within six months or less after a disaster. The CERF provides larger grants to UN agencies that are expected to implement them through national actors (World Bank Group 2017).

Currently, several partners provide international cooperation funding through various programs, projects, and initiatives at the national and local levels. According to the Financial Tracking Service of the UN Office for the Coordination of Humanitarian Affairs (OCHA), in 2016 Zimbabwe received international donor assistance of almost US$166.9 million out of the total $352.3 million required that year. This amount included funding for all disaster events and related sectors, such as water, sanitation, and hygiene; food security and agriculture; and nutrition and health.

Figure 6 shows the Zimbabwe Humanitarian Response Plan from 2008 to 2016. The blue shading represents funding obtained from appeals; the yellow shading represents the deficit that remained unmet (in other words, the funding gap between the total appeal and the amount mobilized).

Notes

1. Vulnerability, a common term in the poverty and food security literature, is defined as "the likelihood that at a given time in the future, an individual will have a level of welfare below some norm or benchmark." Common welfare indicators include poverty measurements, household expenditures, savings levels, and food security and nutrition measures. Though vulnerability depends on the severity of external shocks like climate-related events, the likelihood of a drop in welfare depends both on people's context and on their capacity to act and react. Socioeconomic assets and institutions play an important role in the extent of people's vulnerability.

2. See UNDP (2017), UNOCHA (2016), and ZIMSTAT (2015).

3. MAMID (2012).

4. See EC (2011), the final report of a November 2010 mission to evaluate Zimbabwe's system of official controls and the certification of plants for export to the EU.

5. See also http://www.zimcodex.gov.zw/food-control-in-zimbabwe/.

6. GFDRR (2017).

7. For that review, debt was defined as the total amount the local authority owed to all creditors, including bank debt, payment arrears, and salary arrears, among others.

Chapter 5

TOWARD A RISK MANAGEMENT STRATEGY

The findings of this assessment suggest that agricultural risk is a principal cause of transient food insecurity and disruption to agricultural supply chains. Agricultural risks deepen poverty by preventing rural entrepreneurs (particularly producers) from building their assets, investing in developing their businesses, and paying for healthcare and education. Agricultural risks also exacerbate existing poverty traps in vulnerable populations and lead to uneven growth in agriculture and the economy as a whole. In rural Zimbabwe, crop failure induced by drought is the biggest shock and may also be the biggest poverty trap. The increasing prevalence of "shock-recovery-shock" cycles in Zimbabwe, where the economy depends so heavily on agriculture, is reducing the government's ability to plan and pursue a sustainable development path. Zimbabwe stands to benefit considerably from transitioning toward a more proactive risk management strategy.

Agricultural risk management is a dynamic, changing process that requires periodic assessments of risk, of agricultural stakeholders' risk management capacity, of the strength of public and private institutions involved in managing agricultural risk, and of fiscal constraints. In this sense, all agricultural risk management is a context-specific endeavor. This chapter presents potential components of an integrated agricultural risk management strategy that can serve as the basis for GoZ to improve the mitigation of identified risks, promote risk transfer mechanisms, and/or make ex-ante financial provisions for coping with disasters.

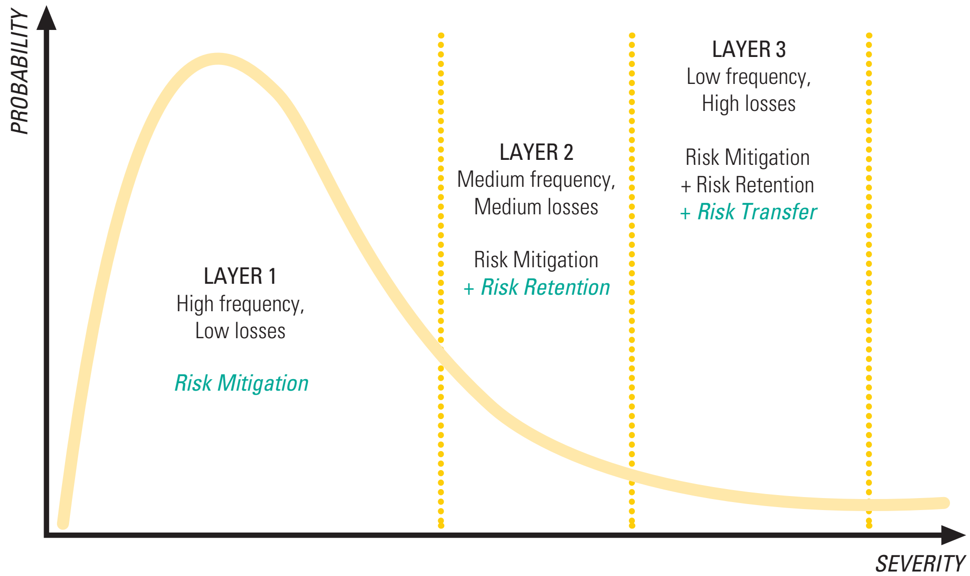
The conceptual framework for these actions is presented in Figure 7. The figure shows a "layering approach" to risk management. In Layer 1, the government invests in adopting and implementing **Risk Mitigation** strategies that strengthen producers' resilience by reducing risks that occur at a low severity and high frequency at the farm level. In Layer 2, where risky events occur at a medium frequency and medium level of severity, the government can use **Risk Retention** strategies such as a contingency fund or contingent credit to finance a response to these events. Finally, Layer 3 is a **Risk Transfer** window for transferring risk to capital markets for risks that are very infrequent and cause high losses that the government cannot limit. By undertaking comprehensive risk assessments for the main commodity supply chains and by adopting a holistic layered approach to identified risk, the government will be in a better position to start managing the main drivers of agricultural volatility and food insecurity.

The findings reported here emphasize that an integrated agricultural risk management strategy for the current context in Zimbabwe must promote risk mitigation measures at the farm level—in other words, it must strengthen the capacity to reduce risk and improve resilience at the farm level. Investing in risk mitigation at the farm level will go a long way to reduce agricultural volatility, manage food insecurity, and help smallholders adapt to climate change.

Of equal importance for the government is the need to make ex-ante provisions and strengthen its capacity to finance and deliver timely assistance when disasters of medium/low frequency and medium/high severity occur. This step is the key to avoiding future food insecurity, particularly in rural Zimbabwe.

Innovative risk transfer programs such as agricultural insurance at the sovereign and farmer level are being implemented in various sub-Saharan countries.

Figure 7. A Risk Layering Strategy for the Government of Zimbabwe



These programs could provide valuable lessons on how to transfer agricultural risk to capital markets in Zimbabwe.

The rest of this chapter provides more specific suggestions for policy makers in Zimbabwe to start identifying risk management strategies that are best aligned with national development policies, priorities, and fiscal constraints.

5.1 Risk Mitigation

Zimbabwean agriculture is turning the corner toward higher growth and productivity, presenting a valuable opportunity to look forward and establish the basis for a sustainable and resilient agricultural sector that reflects the reality of the emerging productive matrix, which mostly comprises large numbers of small-scale producers. At this juncture, rather than opting to re-create the past or to adopt a piecemeal approach, Zimbabwe has an opportunity to see where an evolutionary approach can be replaced by leap-frogging—by jumping over a generation of technical and/or social development and into a new era. Zimbabwe can do this because it possesses plenty of human capital and knowledge. Many educated professionals have left the country during the past decades, and economic difficulties have reduced the strength of agricultural innovation institutions, yet the core of those institutions and expertise remains and is ready to engage and expand as resources become available.

5.1.1 Moving Toward an Enabling Policy Framework

This review identifies three areas in which the AIS will benefit from leap-frogging: (1) shifting the paradigm from conventional, high-input agriculture to knowledge-intensive sustainable intensification of agriculture; (2) leaping from uniform production patterns to more specialized production in a spatial development framework; and (3) pursuing the digitalization of agriculture. If the AIS is to undertake these strategic approaches, it will require policy support and investments to strengthen the public and private institutions behind the AIS that support smallholder farmers and bring about change.

From Conventional Agriculture to Sustainable Intensification of Agriculture

A significant shift is needed to move away from the conventional agriculture paradigm to a climate-smart, sustainable agriculture orientation that focuses on production systems capable of supporting the ecological reconstruction of degraded areas and landscapes through (for example) rehabilitating soil structure and fertility, reforestation, water resource management, sustainable water harvesting and optimized use in agriculture, protected production in horticulture, and the diversification of crop production (supplementing cereals with pulses and high-value crops) and crop rotations, to cite some of the options.[1] It is important to note that the context for this sustainable production paradigm is Zimbabwe's agricultural systems and landscapes. Disciplinary research (plant breeding, soil science, agronomy, and so on) will retain a central role, but its goals and research questions will emerge from the sustainable production paradigm.

From National Production Goals to Regional Specialization

Maize is the staple crop in the food system, and the current policy is to extend maize production throughout the country. For that reason, maize production is being promoted to some extent even where the climatic risks are too high to justify its production. Zimbabwe could benefit from revisiting the idea of regional and agro-ecological specialization, and from identifying the geographical areas that are most suitable for certain crop or livestock systems—for example, pasture and livestock production areas, horticultural crop production areas, maize production systems, and so on—with their associated market clusters and supply chains, with the relevant stakeholders (traders, regulators, processors, financial agents, and others). A first step could be to revisit the agro-ecological zones and suitability of different crops in these zones and identify areas of high dynamism for further cluster development. Linkages between rural towns and adjacent rural and peri-urban areas could be developed jointly in a spatial development framework.

Digitalization of Agriculture

Massive expansion of 3G mobile broadband services across the country—mobile broadband penetration increased more than seven-fold within four years and by 2017 had exceeded 100 percent—means that half of the population now has access to the internet (POTRAZ 2017). Most agricultural researchers and extension workers have access to mobile phones and internet, but they are only just beginning to use these digital tools for sharing information and managing knowledge (Mugwisi et al. 2015). The tremendous growth in mobile and internet access in Zimbabwe provides the foundation to move toward e-agriculture across subsectors and services, including extension, GIS for land management, agro-weather services, governance in institutions, market information, communication among producers and trade organizations, and livestock traceability, to mention a few (World Bank 2017). Embracing the ICT opportunities in agriculture can make a huge difference in reaching the large number of smallholders with technical support and agro-weather information, and for farmers to get better prices for their produce and conclude transactions. Beyond the farmer level, all agricultural institutions will benefit greatly from using ICTs to share information, ease communication, increase the effectiveness of administration, and so on.

An Enabling Policy, Regulatory, and Incentivizing Environment

For all of three of the "leaps," an enabling policy, regulatory, and incentivizing environment is essential. The AIS also needs to engage creatively to "oil" the machine for these transformative changes. One option that could be considered is a strategic initiative to facilitate south-south learning and innovation, which could be resourced by a competitive grant facility to support consortia ready to contribute to leap-frogging.

The most important priority in the short to medium term is the following public investments to strengthen the resilience of smallholder farming systems: strengthening the AIS and SPS system in public-private partnerships, irrigation development, and improving the agricultural early warning systems. These services need strong support from the government, as the vast majority of smallholder farmers have limited capacity to manage agricultural risk, and they need interventions to provide the public goods that can accompany them in leap-frogging toward a more sustainable and resilient agriculture as the country moves forward.

The reality, however, is that resources to strengthen risk mitigation measures among small-scale producers still show a downward trend across all categories of spending (Table 12). Once this trend is reversed, several suggestions for the priority services that need strengthening can be pursued, as discussed in the sections that follow.

Table 12. Annual Budget for Agricultural Services

	Budget (US$ 000s)		
Sector	**2014**	**2015**	**2016**
Meteorological Services	3,838	2,926	2,330
Water Resources Management and Development	79,227	40,439	28,564
Agricultural and Extension Services	36,183	35,110	19,599
Irrigation and Development	15,218	10,703	7,147
Livestock Production and Development Division	6,697	5,082	5,558
Veterinary Services Division	22,109	19,008	12,850
Agricultural Engineering and Mechanization	4,760	5,285	3,531
Civil Protection Unit	550	350	360

Source: Government of Zimbabwe, 2014–2016 National Budget Statement.

5.1.2 Strengthening the Agricultural Innovation System

After the land reform, Zimbabwe has 300 large-scale farmers (farms averaging 2,200 hectares or more); 16,386 resettled A2 farmers (~318 hectares); 145,775 resettled A1 farmers (~37 hectares); 76,000 old-resettled farmers (~46 hectares); and about 1,300,000 communal farmers (~4 hectares). Such a dramatic change in the structure of the farming sector continues to pose an enormous challenge for the AIS. Until the late 1990s, DR-SS and AGRITEX focused on providing services for large-scale farmers. The small-scale farmers in the communal lands were largely left to their own means and innovations. Since the land reform, this dichotomy has disappeared, and the research and extension system must now serve close to 2 million small-scale communal, peri-urban, and resettlement farmers, most of whom depend on rainfed agriculture.[2]

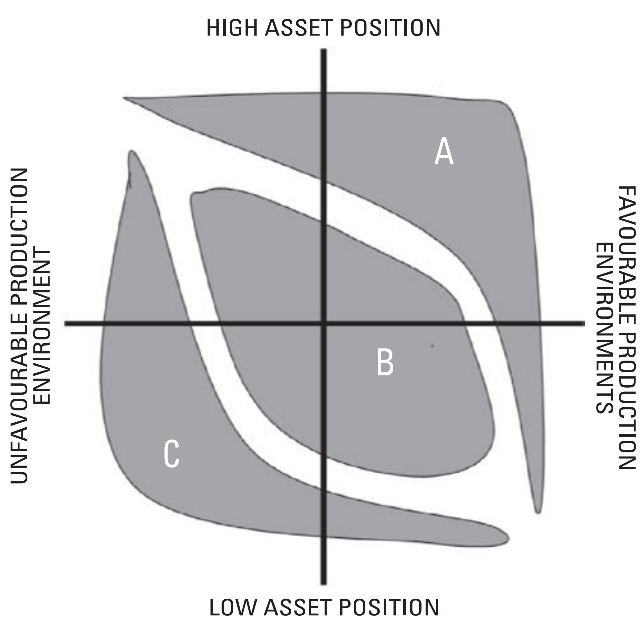
Different Resource and Services for Different Subgroups

Subgroups within these 2 million smallholders will require different types of resources and services from the key innovation system stakeholders (research, extension, agribusiness, and so on). To think through the associated issues, it may be helpful to consider the typology of farmers developed by Berdegué and Escobar (2002).[3] The typology is based on producers' asset ownership (high or low) and production environment (unfavorable or favorable). It encompasses three major types of small farming communities, which would benefit from different types of policy and innovation support (Figure 8):

1. Where assets favor the development of competitive agriculture, particular emphasis should be given to commercial initiatives and private sector contributions.
2. Where farmers have the potential to embark on market-oriented agriculture but are constrained by their asset base, public (and private) efforts should aim to provide resources and experience to develop a vibrant small-farm sector.
3. Where rural households lack many of the assets that might allow them to profit from commercial agriculture, more broad-based rural poverty reduction policies must be pursued, often in collaboration with local organizations, the UN system, and NGOs that can facilitate building linkages and institutions.

Figure 8. Grouping Farmers to Develop Different Strategies for Agricultural Innovation

Figure 1 Differential strategies for the development of agriculture knowledge and information systems



Source: Berdegué and Escobar 2002.

The typology is presented merely to illustrate one way of grouping small-scale farmers to start developing differentiated agricultural development and innovation strategies.

What is Needed for the AIS To Leap-Frog?

The AIS in Zimbabwe has an institutional basis: DR-SS provides public research goods, AGRITEX provides public extension services, and Agricultural Research Council of the Research Council of Zimbabwe facilitates the identification of national priorities, conducts stakeholder consultations, and can manage competitive grant funding systems. These public R&D services are supplemented by research in academia and private companies, especially crop breeding by seed companies. Regional and international agricultural research institutions complement and collaborate with the national AIS. All of the public institutions have a core of capable human resources. <u>But the main constraint of the AIS is its inadequate fit to agriculture as currently practiced in Zimbabwe, its severely limited resources, and the lack of cooperation across the AIS</u>.

- Both DR-SS and AGRITEX, the key public sector agricultural R&D entities, would benefit from a fresh look at their focus and strategies in service of the 2 million small-scale farmers. This process must recognize the different groups among these farmers (defined according to their asset base and environmental production conditions) and their different requirements for R&D support, as suggested in the exercise conducted by Berdegué and Escobar (2002), referenced earlier.
- While the core human resources are present in Zimbabwe's public research, extension, and development institutions, they remain severely limited, along with resources for operations and capital investments for infrastructure. These institutions need to increase the number of researchers and extension agents, but they also need to train and re-train staff in the modes of operation and skills required today (climate-smart agriculture, ICTs, inter-disciplinary research, socioeconomic and gender research, facilitating innovation platforms, and so forth).
- The resource constraints of prior decades have left few opportunities and incentives for inter-agency cooperation and in some cases have led to a coping strategy of isolationist behavior. Once resources become more available, it is likely that cooperation will emerge, although consistent leadership and a clear strategy for cooperation will be important. Competitive grant systems designed for inter-disciplinary and multistakeholder cooperation will further incentivize cooperation.

Given the core human capacity in the country and limited resources, every opportunity for regional and international R&D interaction should be seized. The World Bank–financed Agricultural Productivity Program for Southern Africa could be one such opportunity.

A final point is that for leap-frogging to be successful, the AIS should more clearly reflect the wider perspective on innovation systems and practices that characterizes the AIS approach. An AIS approach looks at the multiple conditions and relationships that promote innovation in agriculture. Compared to traditional, linear agricultural research and extension efforts, the AIS approach may offer a more flexible means of dealing with the varied conditions and contexts in which innovation must occur. It considers the diverse actors involved, their potential interactions, the role of informal practices in promoting innovation, and the agricultural policy context.

The AIS principles of analysis and action integrate the more traditional interventions (support for research, extension, and education and the creation of links among research, extension, and farmers) with the other complementary interventions needed for innovation to take place. Such interventions include providing the professional skills, incentives, and resources to develop partnerships and businesses, improving knowledge flows, and ensuring that the conditions that enable actors to innovate are in place.[4]

5.1.3 Improving Sanitary and Phytosanitary Measures

Aside from the weather-related risks, fieldwork for this risk assessment identified important pest and disease risks for plants and animals, which were included in the risk prioritization assessment in Chapter 4. Although this assessment did not undertake a separate assessment of the SPS system in Zimbabwe, this section advances some potential measures to strengthen the SPS system, which can serve as the basis for prioritizing further research and investments designed to strengthen the public institutions and universities that address these issues.

Phytosanitary Systems

Facilities at the Mazowe Plant Quarantine Station include entomology, nematology, and phytopathology laboratories and the quarantine facilities for imported plant materials, including a small quarantine glasshouse. Detection of harmful organisms is based mainly on visual examination. The equipment available for bacteriology, mycology, and virology is fairly basic, and there are no regular evaluations of the standards of laboratory work (EC 2011).

Participants in the national stakeholder workshop stressed the need to strengthen the capacity of DR-SS and AGRITEX to develop and disseminate pest- and disease-tolerant crop varieties and animal breeds and to test the efficacy of indigenous knowledge systems and medicinal native plants in controlling diseases and pests. In addition, collaboration between public and private agricultural research, education, and extension institutions, which are currently working in isolation, should be strengthened.

The EU has audited the phytosanitary system (EC 2011), and FAO has supported capacity building in this area. The main recommendations emanating from the EC (2011) report are: (1) review the regulatory framework; (2) assess the capacity for implementation (institutional mandates, expertise, infrastructure, operational funds); and (3) phase investments to improve the system. Participants in the stakeholder workshop for this assessment noted the need for the Plant Protection Unit and the Department of Livestock and Veterinary Services to improve public biosecurity measures within the country and at international borders to prevent the transmission of pests and diseases (such as foot and mouth disease, full armyworm, and *Tuta absoluta*) from endemic areas into disease- and pest-free zones. They also emphasized the need to make the required public sector investments to produce animal vaccines (for Newcastle disease, anthrax, rabies, foot and mouth, and tick-borne diseases).

Food Safety

Pswarai et al. (2014), in a review of the food safety system in Zimbabwe, find it to be fragmented, with no clear mechanisms for coordinating the activities of the entities involved. This fragmentation and lack of coordination make it difficult to ensure a safe national food supply. The main reason for these problems is the lack of resources allocated to the food control system, which had been noted previously and led to the draft Food Control Bill (2011). The bill calls for the establishment of a Food Control Authority of Zimbabwe with a comprehensive mandate to ensure food safety. The emphasis in recent years on food production, along with limitations in public resources, have delayed upgrading of the food control system.

5.1.4 Developing Irrigation

Given that drought is the main driver of agricultural risk in Zimbabwe, and given the projected impact of a drier future climate, irrigation development is vital for building resilience. Limited availability of water is a key constraint for small-scale producers. Much irrigation infrastructure is in poor condition, so farmers in irrigated cropping systems are producing below the yield potential. Key priorities for irrigation are to rehabilitate existing infrastructure; adopt more modern, efficient technologies; and expand into under-irrigated areas with good production potential.

5.1.5 Improving Early Warning Systems

The framework established under the UN International Strategy for Disaster Reduction and best practices on early warning systems suggest that four elements are important: the collection and assessment of data on risks, establishment of monitoring and warning services, communication, and the capacity to respond to a risk or hazard.

Zimbabwe's long history of drought and climate vulnerability has led to the progressive establishment of more effective early warning systems, yet a number of opportunities exist to strengthen these systems, improve the coordination of early warning efforts, and use increasingly sophisticated technology.[5] Zimbabwe's well-established hazard and monitoring systems are supported by institutional structures at all administrative levels, including the DCP and Meteorological Services Department, which are the key institutions for disaster risk and preparedness. Even so, there is a need to strengthen cross-institutional coordination for early warning activities that are complementary or require improved coordination across institutions. Investments that develop early warning infrastructure are also needed for Zimbabwe to take advantage of new technology and data sources, which will be particularly important for rapidly triggering financial preparedness and funding responses.

It would also be interesting for Zimbabwe to develop agroclimatic zoning that can help stakeholders make decisions based on historical probability estimates, which can help to forecast the level of risks for specific crops in specific areas. These efforts could be part of the proposed agro-ecological rezoning mentioned earlier.

In addition, early warning systems should be strengthened to increase the dissemination of more location-specific weather and seasonal forecasts to rural communities through digital platforms and the government agricultural extension service. While mobile penetration rates are high in Zimbabwe, some remote areas such as Umguza, Siyakova, and Umzingwane have poor or no mobile network coverage, making dissemination of early warning or market information products by SMS or social media platforms ineffective. Box 1 summarizes a recent diagnosis of the early warning system (World Bank 2018).

The following 10 key recommendations for strengthening Zimbabwe's early warning system are designed to build a stronger system that can manage the effects of a likely increase in climate variability:

- The early warning system should incorporate a wider range of data and analysis. For example, it should expand data collection to enable better baseline comparisons, assess vulnerability in urban areas, include more market information data, and support other sectors that are also impacted by climate variability (health, infrastructure).
- Early warning data and information systems should be integrated into one platform and an open data approach adopted, to allow greater access to source data by all stakeholders and more robust analysis.
- Contingency planning should be expanded in response to increasingly regular ENSO events.
- Early warning products and findings should be more accessible to end users and context specific, particularly for women farmers.
- Institutional coordination should be strengthened, both nationally (across the wide range of departments and organizations involved in early warning data collection) and regionally.
- Technical capacity building and training is needed at the national and local levels to upgrade skills and fill technical staffing gaps.
- Data collection equipment and technology should be upgraded, with greater utilization of digital ICT.
- Consolidate the policy framework across climate, disaster risk management, and early warning for consistency, and move forward with the draft DRM Bill.
- Expand the inclusion of market information into early warning systems for better decision-making.
- Explore options for a sustainable financing mechanism. The ultimate effectiveness of Zimbabwe's early warning system is largely constrained by inadequate funding and increasingly obsolete equipment.

As agricultural risk management needs intense inter-institutional coordination, Zimbabwe could consider developing a Technical Support Unit (TSU) to coordinate issues related to agricultural risk

Box 1. Salient Characteristics and Diagnosis of the Early Warning System in Zimbabwe

- Drought monitoring and warnings are akin to monitoring the impacts of drought rather than climate forecasting.
- Drought policy has a disaster rather than a drought mitigation orientation.
- Zimbabwe has quick response mechanisms for long-term shocks such as drought that are highly effective, while it fails to reproduce the same mechanism for short-term shocks like floods or pest and disease epidemics.
- The limitation in long-range forecasting constrains the potential to transform early warning systems into action that guides drought/flood preparedness.
- Poor utilization of early warning products:
  - Early warning products are released to the public in a generic form that is not specific to the need to trigger a response (in the form of a particular action) among users.
  - Early warning products tend to be available in English and Shona and are not translated into all 16 official languages; as a result, the information cannot be read, heard, and understood by everyone in all regions.
  - The spatial disadvantage of remote areas with poor access to mobile networks makes dissemination of early warning products by SMS or social media platforms ineffective.
- A silo mentality and lack of information sharing prevail among government departments, ministries, NGOS, and academia.
- Funding is released only when the president declares a state of disaster—often after a crisis has already occurred. A disaster risk/early warning systems fund is needed to support mitigation, preparedness, response, and recovery.

Source: World Bank 2018b.

management. The TSU could be housed in the Ministry of Agriculture or in the Disaster Department. The role of the TSU would be to coordinate risk management in agriculture, to perform the related research (risk assessments, maps, support information, databases, and so on), develop the training programs, and develop proposals for high-level decision-makers, including active participation in the early warning system. The TSU could be guided by a high-level steering committee (constituted by representatives of the Ministry of Agriculture, MoFED, disaster risk management office, planning office, and so on) that will be responsible for defining the strategy. The TSU should be supported by a technical committee comprising representatives of public and private agencies, such as insurance companies, universities, extension agencies, research institutions, the Meteorological Services Department, and other concerned institutions.

5.2 Agricultural Insurance

As mentioned at the beginning of this chapter, agricultural insurance is one potential risk transfer tool that farmers and other stakeholders can use to manage risks that cannot be mitigated at the farm level. Insurance instruments transfer part of that risk to another party in return for a fee (or premium). Where it is available and affordable, agricultural insurance (for crops and/or livestock) can greatly benefit farm households:

- Insurance can (and should) be used to complement other risk management approaches. Farmers can rely on informal household- and community-level strategies such as crop and labor diversification to manage small to moderate risks. In the event of a major weather shock, insurance can be designed to protect against revenue or consumption losses, enabling households to avoid selling livelihood assets or drawing on savings.
- Insurance can assist farmers in accessing new opportunities by improving their ability to either borrow money or in-kind credits. In doing so, farm households may potentially experience higher returns.

Crop and livestock insurance products are widely used in high-income countries. Markets are large, and there is long experience in finding ways to insure agriculture with traditional insurance products. Recent experiences in insuring smallholders with innovative index products can be relevant for Zimbabwe. Because the discussion in this assessment emphasizes particular types of crop insurance products corresponding to a specific set of risks, a broad discussion of agricultural insurance (including livestock insurance) is not undertaken here.[6] Instead, the following sections review the differences between a subset of traditional and non-traditional crop insurance products.

Smallholder farmers' uptake of agricultural insurance has been historically very low in Zimbabwe, and at the same time Zimbabwe has seen limited investment toward the provision of market-based insurance services for this sector. Smallholders often suffer the full impact of poor weather on their crops because, unlike commercial farmers, they are unlikely to take out insurance to transfer the risk, opting instead to rely mainly on the limited risk mitigation strategies they can implement themselves at the farm level. With the recent and continuous piloting and implementation of index insurance projects in various countries in sub-Saharan Africa, however, some opportunities may be emerging for Zimbabwe.

Weather index insurance (WII) is an innovation with advantages beyond traditional agricultural insurance, which bases indemnity payments on verifiable losses. Index insurance pays out benefits based on a predetermined index—such as the average yields in an area, rainfall, temperature, or a normalized difference vegetation index (NDVI)—that is correlated with actual loss of assets and investments. An indemnity is paid whenever the realized value of the index exceeds or falls short of a previously specified threshold, without requiring the traditional services of insurance claims assessors. Because field loss assessments are not needed, administrative costs can be drastically reduced. Index insurance can therefore be sold at lower prices and pay out claims more rapidly. Index insurance also reduces moral hazard[7] and has low adverse selection,[8] given that an objective trigger is used for claim payments. This combination of factors improves the potential for the insurance product to be commercially sustainable.

Four innovative models of WII have been implemented recently in sub-Saharan Africa, including one type piloted in Zimbabwe by the World Food Programme under its R4 Rural Resilience Programme. Box 2 describes these efforts and the lessons they present. These examples (among many others) indicate the potential for innovation in this field, and it is worthwhile to examine them more closely and evaluate their feasibility for Zimbabwe. Implementing such

Box 2. Recent Innovations in Weather Index Insurance in Africa

The World Food Programme's R4 Rural Resilience Initiative (Zimbabwe). This initiative supports the provision of weather index insurance (WII) to 500 beneficiaries in Chebvute, Masvingo District. Coverage begins only after enough rain has fallen to permit a farmer to plant. If this "effective rainfall" is not experienced by December 5, the policy automatically starts on December 6. Farmers will be covered for the following 85 days, encompassing the germination, vegetative, and flowering periods of the growing season. Rainfall is monitored using satellite information specific to the geo-location of each farmer's village, and monitoring is supported by manual rain gauges. If a rainfall deficit is experienced, payouts are triggered automatically. The sum insured is based on the value of the agricultural inputs. If triggered during the germination period, payouts will cover 20 percent of the sum insured; a payout of 40 percent of the sum insured will be disbursed during the vegetative period; and 60 percent will be triggered during the flowering phase. A farmer can receive only one payout per policy.

Seed protection (Rwanda, Tanzania, Kenya). This product covers the loss of a bag of seed; payouts occur when there is not enough rain for seed to germinate during a 21-day planting window for a given location. The product aims to enable farmers to afford a second purchase of seed and to replant during the same season. The seed company introduces a voucher (a scratch card with a code) in each 2-pound bag of seed. The farmer needs to dial a predetermined number of the mobile operator to register and enter the voucher code. When the farmer activates the code, the mobile network picks up the location where the phone call is made, and the farmer is insured as a beneficiary of the policy for that location. Technical support is provided by the Agriculture and Climate Risk Enterprise Ltd to the insurer for designing and pricing the contracts for maize at the different locations using satellite weather data (past and current), with the assistance of the International Research Institute of Climate and Society at Columbia University.

The seed company pays a percentage of the insurance cost and donors pay the remainder based on a previously agreed subsidy model. Whereas the insurance pricing is done by location, the seed company and donors pay upfront an aggregated risk premium (of around 10 percent) to the insurer. The compensation is sent to the farmer via mobile money. The farmer can then purchase seed, replant, and potentially harvest in the same season, or obtain cash in compensation. In participating in this project, Seed Co has incurred the added costs of repackaging seed to include the insurance voucher and paying their share of the premium. These costs have been justified in terms of market differentiation, securing customer loyalty, and increasing their market share in Kenya (5 percent) by promoting their drought-resistant seed.

Livestock insurance as social protection (Kenya). Developed by the International Livestock Research Institute and sold to individual pastoralist households in various districts of Kenya at subsidized levels (around 40 percent of commercial premiums), this livestock insurance product has evolved rapidly. Originally covering mortality levels following catastrophic events, the product now reflects an asset protection approach and covers financial losses incurred when animals become stressed by drought. Satellite observations are used to derive a normalized difference vegetation index (NDVI) that proxies pasture availability. A model is used to correlate the NDVI with livestock mortality or animal stress occurring when forage is unavailable. The product acts as an early detection mechanism that triggers payouts before animals die, and it should help herders to keep their animals alive. Pastoralists pay the risk premium, which is set at the actuarially fair price, and donors pay the subsidy premium of 40 percent, which allows the insurance company to cover costs and earn a profit. Commercial premium rates are around 8 percent of the insured amount. The program started in 2010 and is now available in several regions of northern Kenya.

A number of technical lessons have been learned through this experience. For example, it is necessary to calibrate the index to specify precisely whether a particular level of greenness reflects vegetation that is edible or palatable to cattle, by adapting the filters used to interpret the satellite observations in any particular context. The product evolved into an asset protection product because the historic data on mortality required to trigger payouts was not available everywhere, and because herders and insurers were not so interested in the initial mortality contract.

In 2015, with technical support from the World Bank, the Government of Kenya started buying the product to protect 5,000 vulnerable households from drought as another component of the government social safety net.

Insuring input loans in integrated supply chains (Zambia). This WII product is designed to protect the value of inputs obtained by credit extended to cotton farmers. It uses satellite weather data estimates to price the risk and for monitoring the contract, protecting farmers through the different phases of the crop cycle. It measures cumulative rainfall over 20 days for drought-prone periods during the crop cycle to trigger payments when precipitation is less than an agreed percentage of normal. The index also measures cumulative rainfall over any 10 consecutive days for some periods of the crop cycle with risk of excess precipitation and triggers payments when precipitation is some agreed percentage over normal rainfall levels. The product is promoted by MUSIKA (an NGO) with the participation of the input supplier NWK and the Mayfair and Focus insurance companies as underwriters. Farmers are charged an unsubsidized premium rate of around 8 percent, advanced by NWK at the beginning of the season as part of the input credit. Farmers' enrolment in this insurance scheme is voluntary. NWK advances the premiums upfront to the insurer at the beginning of the season and recovers those premiums from the ginneries that receive and process the seed cotton farmers deliver at the end of the season.

The strategy is to identify an insurance distributor that has wide outreach to farmers, and NWK presented the opportunity, as all cotton farmers use improved seed and fertilizers. NWK has positioned itself in the market as a supplier of improved seed with a market share of around 25 percent, and it saw WII as an opportunity to protect its credit and retain clients. This type of insurance program could work in integrated supply chains.

models would require the establishment of public-private partnerships, funding from donors, and the support and participation of universities, specialized consultants, Zimbabwe weather and information systems, and potentially a risk pool of local insurers to underwrite the contracts.

While many of the risk mitigation strategies and risk transfer products discussed here can help households cope with the impact of low and moderate weather risks, they need to be complemented by government support when larger, more severe weather shocks or natural disasters occur. In such cases, most countries trigger disaster emergency programs that include providing support to the poorest households to ensure food security, assisting small-scale producers to return to productive activities, and rehabilitating infrastructure.

5.3 Sovereign Disaster Risk Management

Investing in risk mitigation at the farm level can go a long way to strengthen the resilience of agricultural systems. Risk mitigation at the farm level is not enough, however, considering that Zimbabwean agriculture remains highly vulnerable to severe natural disasters. Given the high costs of these events in terms of losses in agricultural output, reduced incomes, and negative effects on food security, the country also needs to have the institutions, processes, and financing in place to reach affected households in a timely way through ready-made programs that help them recover from shocks and avoid cyclical poverty traps, especially the most vulnerable households. In other words, the GoZ requires the capacity to respond rapidly through ready access to a package of various sources of finance that can be used for meeting the costs of different levels of impacts.

Zimbabwe is susceptible to extreme weather events such as droughts, heat waves, heavy rains, flash floods, strong winds, and hailstorms. The country has experienced a total of 18 ENSO events since 1951, and historical records show that 62 percent of ENSO episodes since 1970 have been characterized by low and erratic rainfall (UNDP 2017). Six of these recorded ENSO events have been categorized as either strong or severe. Combined with limited adaptive capacities, these events have caused food insecurity to peak every four to five years in Zimbabwe and across southern Africa, with each episode lasting 9–18 months.

As noted, the costs of these losses have been met by limited domestic fiscal resources and international humanitarian assistance. The failure to use appropriate risk financing instruments to transfer risk to international markets has left wide financial gaps to fund disaster costs.

5.3.1 Financial Gap and Sources of Funds

In the absence of consistent annual evaluations of the total costs of natural disasters in Zimbabwe, the figure used for this analysis is taken from the total pledge requirements that the GoZ has submitted to UN organizations and other donors since 2008. These data are used as a proxy to estimate the financing requirements for disaster risk management on a yearly basis (Table 13).[9]

These figures include expenses for direct emergency support as well as programs related to humanitarian crises. The total yearly average requirement (2008–16) for disaster risk management has been around US$333.3 million. Such requirements have been met with MoFED allocations to disaster risk management programs and to the Civil Protection Fund for an estimated annual average of US$5.2 million (or 1.6 percent of the average annual requirements). The largest source of disaster financing has come from humanitarian sources, including UN and non-UN agencies, with an estimated annual average of US$246.8 million (74.1 percent of total requirements). These allocations from MoFED and humanitarian responses still do not cover the total requirements. They leave an estimated annual average funding gap of US$81.1 million (24.3 percent of average annual requirements).

Disaster risk financing in Zimbabwe has relied on humanitarian funds owing to the severe fiscal constraints of the government balance sheet, and this situation is likely to continue until the economy revives. MoFED earmarks around US$35 million a year for contingencies. In times of tight budgeting, that fund is meant to cover many other contingencies arising from all sectors of the economy and not only those arising from natural disasters. In practice, MoFED makes relatively small allocations on a yearly basis to devote to immediate rescue and emergency operations following disasters, recognizing that humanitarian assistance takes time to approve and disburse. Yet even if MoFED were to allocate all of its contingency fund to natural disasters and emergencies, it would not cover the estimated average annual gap. There are no financial margins to cushion the

Table 13. Estimated Financing Gap in Disaster Risk Management in Zimbabwe

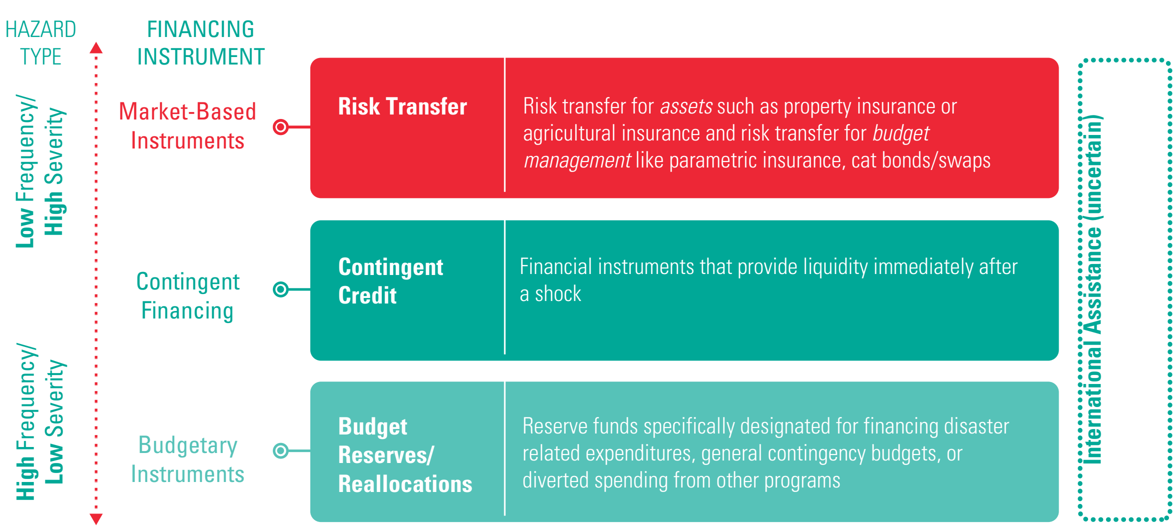
Year	Total requirements for DR financing (US$)	GOZ allocatlions to DRM programs (US$)	GOZ allocatiions to civil protection fund (US$)	Humanitarian Response: Inside UN response/ appeals (US$)	Humanitarian Response: Outside UN response/ appeals (US$)	Financial gap
	*	**	**	***	****	*****
2008	583,447,922	—	—	400,468,563	72,079,089	110,900,270
2009	722,198,333	4,551,190	131,848	456,361,623	185,877,162	75,276,510
2010	478,399,290	10,003,779	172,976	226,189,188	90,042,159	151,991,188
2011	478,582,358	8,171,436	236,000	221,723,553	9,086,250	239,365,119
2012	238,444,169	3,658,232	439,328	206,902,892	27,395,486	48,231
2013	146,971,839	7,409,327	113,600	76,494,116	18,015,731	44,939,065
2014	—	1,182,50	241,080	—	—	(1,182,506)
2015	—	3,196,285	176,000	—	—	(3,196,285)
2016	352,318,995	8,998,717	110,000	166,855,915	64,434,960	111,919,403
Average	**333,373,656**	**5,241,275**	**180,092**	**194,999,539**	**51,881,204**	**81,117,888**
%	100.0%	1.6%	0.1%	58.5%	15.6%	24.3%

Sources:
* UN OCHA Financial Tracking Service (FT5) as Sep 2018
** Department of Civil Protection (2018)
*** Response from the UN system
**** Response outside the UN system
***** Estimated financial gap

effects of agricultural risk and natural disasters, and the country absorbs the shocks without transferring any of the risk to international markets.

In this context, a key challenges for Zimbabwe is that apart from the contingency funds and humanitarian assistance, it has limited financial instruments to facilitate rapid access to significant sources of financing when a disaster happens. Zimbabwe needs to begin transitioning away from its current reactive strategy of managing agricultural risks and natural disasters after the fact and moving toward a planned and proactive financial risk management strategy. In other words, not only does Zimbabwe need to invest in risk mitigation at the farm level, but—as circumstances allow and the country enjoys more financial flexibility—it should start planning to improve its financial preparedness to manage risk and respond to disasters. Like many other countries, Zimbabwe could start by implementing a risk layering approach that combines the use of different financial instruments depending on the frequency and intensity of the risks the country faces. Figure 9 illustrates

Figure 9. Zimbabwe: Financial Risk Layering to Respond to Natural Disasters



Source: Disaster Risk Financing and Insurance Program, World Bank Group.

layered risk financing strategies that Zimbabwe could identify and implement as circumstances allow.

The objective would be to move toward a proactive (and more cost-effective) approach to financial planning to protect national budgets, as well as to shield the lives and livelihoods of rural people from the impacts of disasters, like those experienced during severe ENSO episodes and flash floods. This approach would help the government to consider climate shocks as part of its fiscal risk management strategies. It would also complement other elements of a comprehensive disaster risk management strategy, ranging from investments in risk reduction to designing shock-responsive social safety nets.

Financial protection involves planning ahead to better manage the cost of disasters, ensure predictable and timely access to needed resources, and ultimately mitigate long-term fiscal impacts. By combining various financial instruments—such as contingency budget, contingent loans and grants, and risk transfer solutions—financial protection allows governments to manage the full range of disaster impacts. Different instruments help address different risks (ranging from recurrent to more rare events) and different funding needs (ranging from short-term emergency relief to recovery and reconstruction) (World Bank 2016b).

In many countries, contingency/reserve funds are used to finance relief, rehabilitation, reconstruction, and prevention activities for national emergencies. Sovereign funds specifically dedicated to disaster response exist in Colombia, Costa Rica, India, Indonesia, the Lao People's Democratic Republic, the Marshall Islands, Mexico, the Philippines, and Vietnam, among others. A number of other countries are working to establish similar funds. In Kenya, for example, the government is in the final stages of operationalizing a national contingency fund dedicated to drought emergencies.

Contingent loans are financial instruments designed to give countries access to liquidity immediately following an exogenous shock, such as a natural disaster. They are typically offered by multilateral development banks and international financial institutions (including the World Bank, Asian Development Bank, Inter-American Development Bank, and International Monetary Fund).

Market-based risk transfer solutions are used in every sector of the economy and have growing relevance in development due to increased exposure to risks that result in economic loss. A broad menu of underlying instruments—derivative contracts, insurance contracts, and catastrophe bonds—can be used to transfer the risk of specific meteorological or geological events (droughts, hurricanes, earthquakes, and floods) to actors in the market (insurance companies, reinsurance companies, banks, and investors) who are willing to accept them at a price.

At the highest levels of intensity of natural disasters, there is a need to transfer risk to international markets through some type of reinsurance or insurance scheme. In this regard, Zimbabwe signed a memorandum of understanding with the African Risk Capacity (ARC) in 2012. ARC is a Specialized Agency of the African Union that provides risk-pooling services in the form of catastrophic indexed insurance to governments against severe drought. Zimbabwe is making the final arrangements to subscribe to this transfer instrument.

Another type of instrument that transfers agricultural production risk to international markets is agricultural insurance. In this regard, lessons from other countries (Box 2) suggest that a sound approach is to establish a public-private partnership with agricultural stakeholders, including the insurance companies. This partnership could identify the constraints for insurance market development, adopt policies and investments tending to develop the agricultural insurance market, and identify the models and scenarios where agricultural insurance makes sense. Some initiatives already exist. For example, in 2016, Blue Marble, a consortium of nine insurance companies, launched a pilot for agricultural index insurance in Zimbabwe. The piloted products aimed to protect maize, paprika, and other crops grown by smallholders against drought.

5.3.2 Adaptive Social Protection

One use of the funds made available by risk financing strategies is to support vulnerable households through social protection interventions. The Adaptive Social Protection (ASP) approach that has emerged in recent years was first conceived as a series of measures to build resilience to climate change among the poorest and most vulnerable people by combining elements of social protection, disaster risk reduction, and climate change. Since then, the term "adaptive" has come to be understood by social protection policy makers and practitioners as the need to ensure that the social protection system can adapt safety net programs to respond to all types of shocks (World Bank 2018).

ASP typically encompasses two types of measures. The first type is deployed before shocks occur and aims to boost the resilience of the most vulnerable households. This resilience-building approach seeks to break the cycle of poverty and vulnerability. For example, a household is better at withstanding ENSO shocks if it has more human capital and can access job opportunities, accumulate physical capital, and diversify livelihoods.

The second type of ASP measure focuses on increasing the capability of social safety nets to respond to shocks just before, during, and after a disaster has occurred by introducing flexibility and scalability in program design. Such design features enable faster adjustment to meet post-shock needs. Conceptually, the safety net system becomes capable of "scaling out" to households affected by shocks beyond its regular beneficiaries and/or "scaling up" to increase benefit amounts or frequency of transfers to existing social safety net beneficiaries at a time of acute need. For slow-onset shocks, programs can ideally reach the most vulnerable households before the shock leads them to adopt depletive coping strategies (such as reducing consumption, foregoing care, selling assets, pulling children from school, and so on).

Increasing support to existing social safety net beneficiaries during a severe climate shock and temporarily supporting other households affected by shocks can be an efficient mechanism to mitigate impacts. Indeed, it can leverage existing public works or cash transfer programs and their instruments, including targeting mechanisms, outreach staff, and payment systems. This approach offers an opportunity to build on existing platforms to horizontally and vertically scale in the wake of a shock. It is also fundamental that those platforms are functional and have the trust of external donors. Electronic registries, for example, can guarantee transparency, accountability, and efficiency in assisting vulnerable households in the aftermath of a shock. Existing programs can then serve as conduits to rapidly and efficiently deliver assistance to households in the most affected areas. Recently this approach reached existing beneficiaries who were affected by disasters in Fiji and the Philippines, as well as households affected by climate shocks in Senegal and Mauritania.

Notes

1. The Tropical Soil Biology and Fertility program of the International Center for Tropical Agriculture (CIAT) has developed the concept of "non-responsive" soils, which have lost most of their organic carbon and nutrient-holding capacity. Application of mineral fertilizer will not lead to a yield response, as all fertilizer will wash out of the soil and cannot be retained. Such soils already exist in many communal areas in Zimbabwe, where excessive tillage-based agriculture on sandy soils of granitic origin has degraded the organic matter content. Most of these soils need to be brought back into production by increasing the organic matter content first, before fertilization will make any difference. Options for doing so include (1) an increased biomass input in which large quantities of animal or green manure are applied, (2) conservation agriculture, and (3) agro-forestry (Vanlauwe et al. 2010; C. Thierfelder, pers.com.).
2. See https://gain.fas.usda.gov/Recent%20GAIN%20Publications/Zimbabwe%20Agricultural%20Economic%20Fact%20Sheet_?Pretoria_Zimbabwe_9-22-2015.pdf.
3. See https://www.odi.org/sites/odi.org.uk/files/odi-assets/publications-opinion-files/5208.pdf.
4. World Bank (2012).
5. World Bank (2018b).
6. For a detailed discussion of the development of agricultural insurance and the role of governments in that effort, see Mahul and Stutley (2010).
7. Moral hazard is the perverse incentive to assume a higher level of risk because somebody else is bearing the costs of that risk. For example, a farmer may not adequately look after the crop to prevent damage from drought, because it is insured.
8. Adverse selection occurs when an individual's demand for insurance is positively correlated with the individual's risk of losses. In agriculture, this situation encourages a high proportion of farmers to take insurance, which in turn raises premiums.
9. These preliminary estimates are based on information from the GoZ, international agencies, and qualified informants during the development of this report.

Chapter 6

CONCLUDING REMARKS

This report has presented findings of the assessment of agricultural risk and diagnosis of the disaster risk financing currently in place in Zimbabwe, undertaken by the World Bank at the request of the GoZ. In general, this report shows that shocks along Zimbabwe's agricultural supply chains directly translate to volatility in agricultural GDP as well as impacts on overall economic growth, food security, and the fiscal balance. Zimbabwe is highly exposed to agricultural risks and has limited capacity to manage risk at various levels. The resulting annual losses represent 7 percent of agricultural GDP on average, severely affect vulnerable rural communities, and force the government to shift limited fiscal resources away from development to cope with the effects of agricultural risk. When catastrophic disasters occur, the economy absorbs the shocks, without benefiting from any instruments that transfer the risk to international markets. The increasing prevalence of "shock-recovery-shock" cycles impairs Zimbabwe's' ability to plan and pursue a sustainable development path. Going forward, Zimbabwe will benefit from moving toward a more proactive risk management strategy as it turns the corner toward recovery in its agriculture-based economy, which relies on a vast number of smallholders who are highly exposed to agricultural risks and have limited capacity to manage them.

The findings presented here confirm that it is highly pertinent for Zimbabwe to strengthen the capacity to manage risk at various levels, from the smallholder farmer, to other participants along the supply chain, to consumers (who require a reliable, safe food supply), and ultimately to the government to manage natural disasters. Based on the fieldwork and analytical work for this assessment, it is increasingly apparent that the public sector has a key role to play, not only in correcting the present asymmetries in risk management but in assisting the large number of rural poor and vulnerable households to become more resilient.

This report emphasizes that an important component of an integrated agricultural risk management strategy for Zimbabwe's current context is to invest in risk mitigation measures that help small-scale producers to strengthen the natural capacity for resilience and reduce risks at the farm level. Investing in risk mitigation at the farm level can go a long way to reduce agricultural volatility, manage food insecurity, and assist smallholders to adapt to climate change. To meet these needs, the report suggests strategic steps for Zimbabwean agricultural systems—and equally important, the public sector services that support them—to leap-frog beyond current perspectives and approaches to meet the needs of an agricultural economy largely defined by the needs of small-scale producers whose realities are changing in concert with the climate. For example, innovations in commercial agricultural insurance in various sub-Saharan and other countries are worth studying for their potential to transfer risk in Zimbabwe whenever possible.

Another important point is that the public sector must lead the way in strengthening the government's capacity to provide timely assistance with the most severe and catastrophic disasters. Specifically, Zimbabwe should start transitioning away from its current reactive strategy for managing agricultural risk and move toward a proactive financial risk management strategy, in which financial resources and delivery mechanisms are in place before agricultural risks materialize. In other words, Zimbabwe should structure financial risk management strategies to improve financial preparedness for disaster response. Like many countries, Zimbabwe could start implementing a risk layering approach combining different financial instruments that can be used depending on the frequency and intensity of the risks the country faces.

It is hoped that the results and recommendations of this assessment will serve as a basis and springboard for an analysis of the options for Zimbabwe to implement a range of measures to reduce volatility in agriculture and the wider economy, strengthen food security, and minimize the fiscal risk derived from natural disasters.

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APPENDIX A

DESCRIPTION OF AGRICULTURAL SUPPLY CHAINS USED IN THE RISK ASSESSMENT

Maize

Maize is produced by both small-scale, mainly communal, and larger-scale farmers. In resettled areas, small-scale farmers are in A1 resettlements while large scale farmers are in A2. The degree of mechanization in maize farms has declined tremendously as a result of the Fast Track Land Reform. Highly mechanized large commercial maize farms were converted into farms on small holdings during the reform.

Farmers are represented by various farming associations—for example, the Zimbabwe Farmers Union (ZFU) and Zimbabwe Commercial Farmers Union (ZCFU). Farmers get inputs from agro-dealers and the key agribusiness players in Zimbabwe are Seed Co, Pannar, Pioneer, ZFC, and Windmill, among others. The other key players in the maize value chain are processors such as National Foods, Grain Millers Association of Zimbabwe (GMAZ), and Blue Ribbon, and the government, through the GMB. The GMB is the main regulator of maize marketing in the country.

Groundnuts

A majority of communal maize farmers also produce groundnuts. About 75 percent of groundnut farmers are in communal and resettlement areas, while only 25 percent are in commercial, A2, and other agricultural areas.[1]

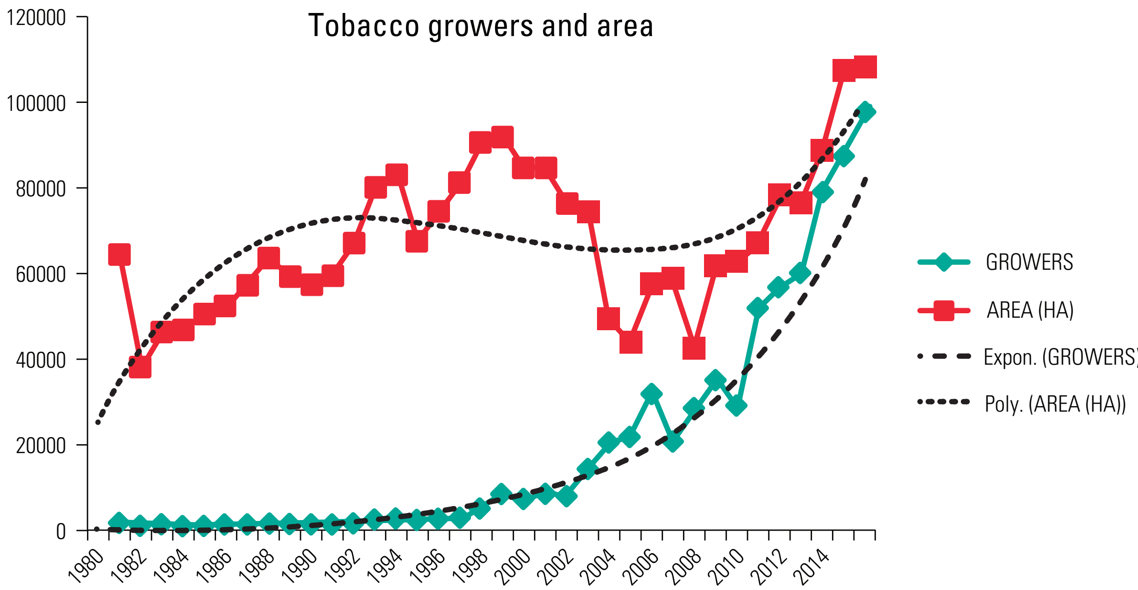
Because of the lack of scale in production, groundnuts produced by commercial and A2 farmers are consolidated and traded through rural agro-dealers such as Mbare traders, Inter-grain, and Peak holdings. Many smallholder farmers produce just for subsistence and also sell to farm-gate buyers. Consolidated produce from large-scale farmers is sold to GMB and processors such as Lions, Agriseeds, Agricom, Reapers, and small-scale processors, among others. Other groundnut value chain actors include NGOs, farmers' associations, banks, and government extension. The marketing of groundnuts is not highly controlled as in maize. The Agricultural Marketing Authority is involved in export-import regulation of the crop.

Tobacco

Tobacco is grown in Regions II and III by both communal and commercial farmers, but today there are more small-scale tobacco growers than larger commercial farmers. From the early 2000s, the number of tobacco growers has increased exponentially (see Figure A.1). Besides farmers, traders and processors (cigarette manufacturers), there are a number of institutional players in the tobacco supply chain (see Figure A.2). The Tobacco Industry Marketing Board is the tobacco regulatory board in Zimbabwe.

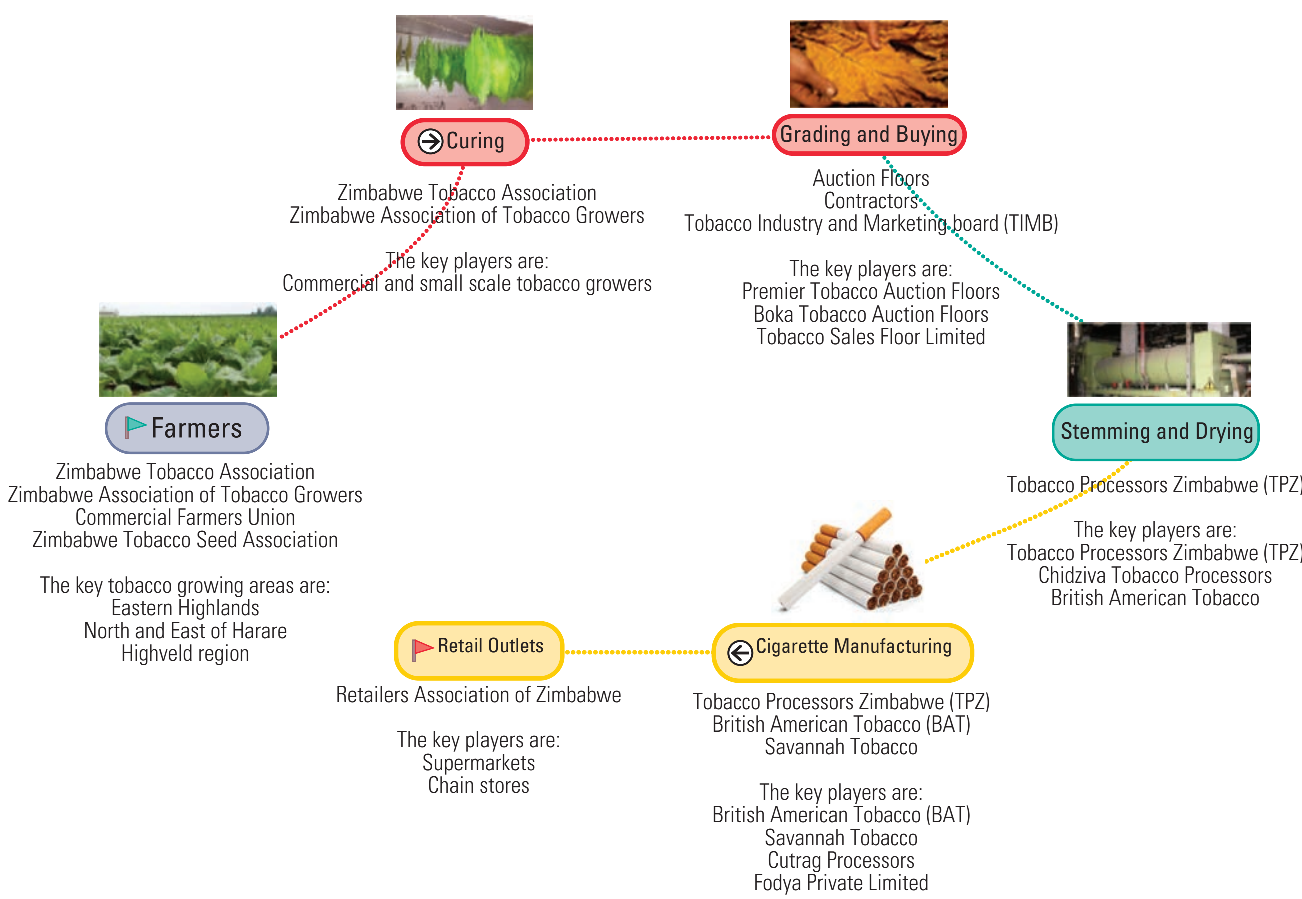
The tobacco supply chain is well organized. Price discovery works reasonably well. Price volatility in tobacco is not a serious risk for tobacco farmers, as international price exhibits moderate variability. Contract farming, which is common among tobacco farmers, contributes to the stability of the supply chain. Farmers are provided with inputs on credit and allowed to pay back at the end of the season after harvesting. Farmers under contract farming arrangements are required to take insurance against natural risks. The contract is offered as a package, including the farmer's insurance.

Figure A.1. Tobacco Growers and Area



Source: MAMID.

Figure A.2. Tobacco Supply Chain Actors



Seed cotton

Cotton farming has shifted from large-scale commercial farmers to smallholder farmers since the mid-1990s, following continued decline in international lint prices that caused a downward trend in local prices. Cotton is currently grown predominantly by smallholder farmers (communal, old resettlement, A1, and small-scale commercial) in marginalized and dry rural areas. Many smallholder farmers are women and youths.

The vast majority of these smallholders use basic equipment, such as animal-drawn implements to prepare land and knapsack sprayers to control pests. Most of the labor is from the family, although hired labor can be engaged for cotton picking and weeding. Cotton production is structured almost entirely around contract farming (98–99 percent of farmers), driven by contracting companies registered as ginners.

There are several private ginners and a government one (Cottco). Suppliers of agricultural inputs (fertilizers, agro-chemicals, and seed) used by farmers are regulated by the Ministry of Agriculture, Mechanization, and Irrigation Development (MAMID) through DR-SS. Figure A.3 shows the cotton supply chain in Zimbabwe.

Sugarcane

Sugarcane is an important crop in Zimbabwe. The industry provides sugar and ethanol as main products and bio-electricity, molasses, and carbon dioxide (among other byproducts) that are of value to consumers in food industry and energy sectors. About 65 percent of the sugar produced is for the domestic market and the remainder is exported to the region, USA, and EU.

Sugarcane in Zimbabwe is grown under full irrigation in the South-East Lowveld areas of Masvingo and Manicaland Provinces on the basis of a dual structure: large scale corporate estates and small- to medium-scale resettlement farms (A2). Hippo Valley, Triangle, and Chisumbanje are the estates.[1] The three estates are vertically integrated into processing, whereby sugarcane is milled into the two main products (sugar and ethanol) and several byproducts. About 80 percent of Zimbabwe`s sugarcane crop is produced by these three large estates, with the remainder produced by private smallholder farmers. Figure A.4 illustrates the sugarcane supply chain in Zimbabwe.

Among the A2 farm owners in old and new resettlement areas, about 50 percent are female-headed households, with only 10 percent of females owning farms in their own names. An estimated 10 percent of farm owners are households headed by children who inherited the farms after the deaths of their parents. Women, who make up an estimated 10 percent of the labor force on sugarcane farms, are involved in light duties such as office administration, weeding, fertilization, and trashing.

Figure A.3. Cotton Supply Chain

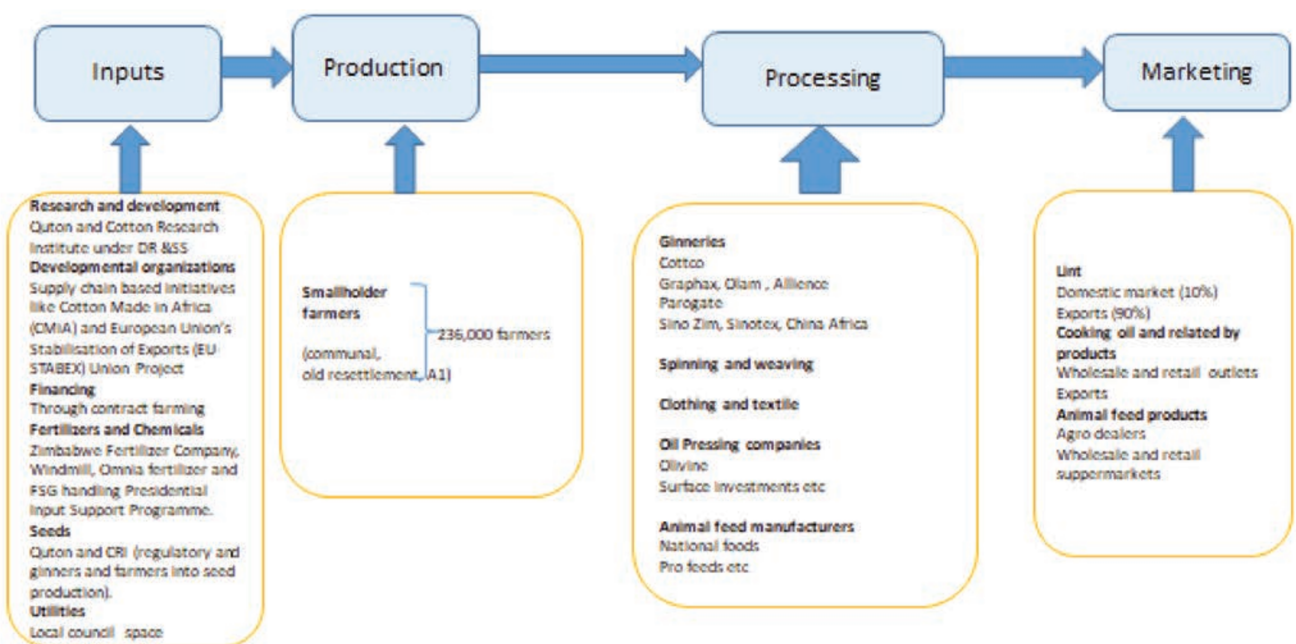
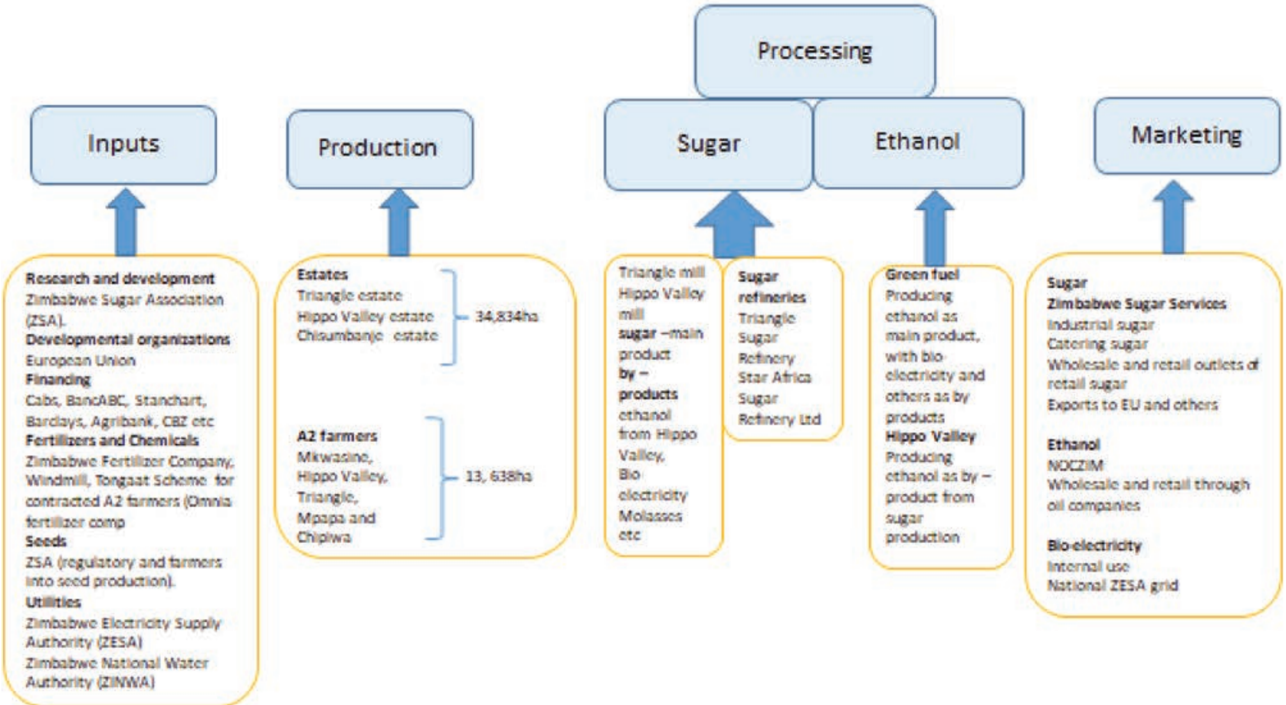


Figure A.4. Sugarcane Supply Chain



Some A2 farmers produce their sugarcane and sell to the company, whereas numerous independent A2 farmers depend on the services of the sugar milling plants to mill their sugarcane at a fee (18 percent), with the value of the cane determined by its sugar content (in other words, a monopsony market organization exists in the sugar milling business). Extension services for large estates are entirely private, while among the A2 farms, both the milling company and government provide extension support.

Wheat

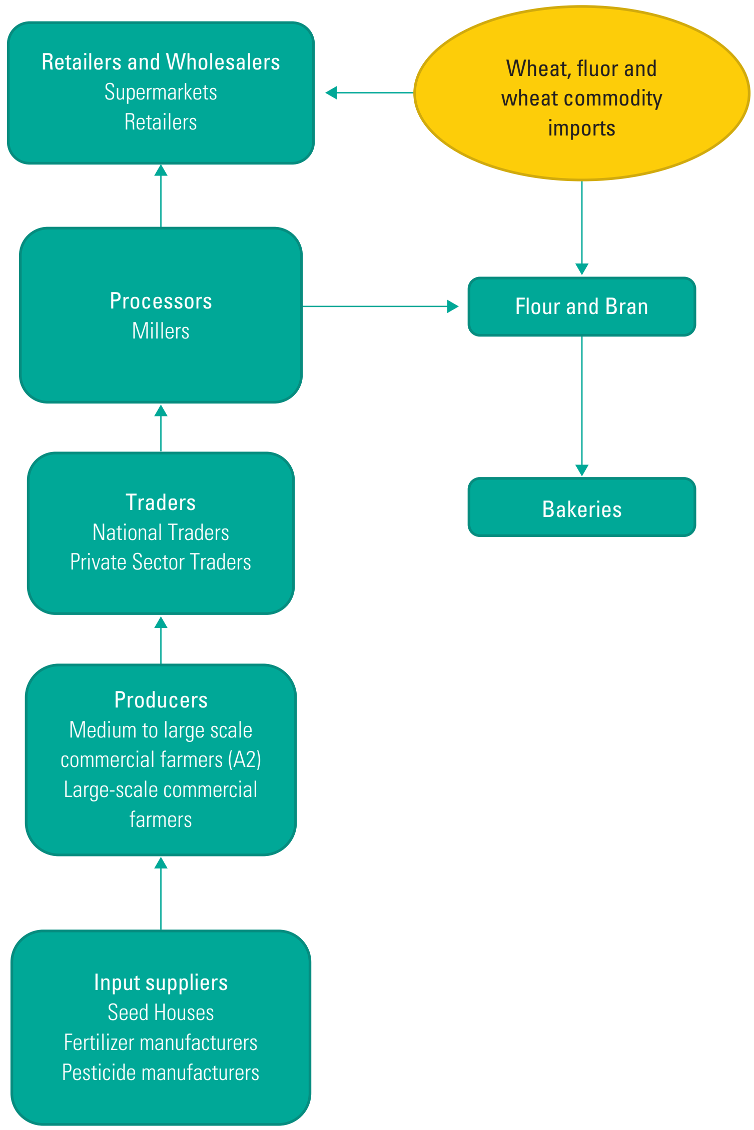
Wheat became popular as a staple crop due to high demand for flour and bread. Wheat is grown during the winter, as it requires low temperatures for high productivity and successful crop development. It also requires irrigation, which limits wheat production to areas close to dams, reservoirs, boreholes, sprinklers, and electricity. As a result, wheat is associated with high production costs, and most producers are medium- to large-scale commercial farmers (A2) located in Mashonaland and Manicaland Provinces. These farmers are affiliated with organizations such as ZFU and ZCFU.

The wheat supply chain comprises several actors (producers, processors, traders, retailers, and consumers). Figure A.5 highlights how they are linked.

The wheat supply chain starts with the input suppliers who provide the seed, fertilizer, and crop chemicals that are needed by the producers. During recent years the supply of inputs has been crippled by the liquidity crisis, which makes it difficult to procure the raw materials needed for manufacture. The main input suppliers in the country are ZFC, Windmill, and National Tested Seeds.

The main grain trader in the country is GMB, which purchases wheat from commercial farmers based on a predetermined government market rate. Apart from being a trader, the GMB is a national storage facility. GMB occasionally rents out its silo storage facilities to private traders such as CropLink, Staywell, and Intergrain Enterprises. There are several milling companies (from small scale to large scale) that are involved in the processing of wheat. The major player is National Foods. Other wheat processors are GMB, Blue Ribbon, and Premier Milling. The main wholesalers include Mahommad Mussa, OK Mart, N Richards, and Metro & Peech, which are found extensively in the cities and towns in Zimbabwe. The retailers

Figure A.5. Wheat Supply Chain



are wholesalers, retail supermarkets, bakeries, and restaurants.

Horticulture

Horticulture is a specialized subsector that is currently Zimbabwe's fifth-largest agricultural export earner. It contributes 6.5 percent to agricultural GDP. Horticultural production occurs mainly in the country's agro-ecological Regions I and II. Production is conducted within close proximity to major urban centers, along the roads that link urban settlements.

Horticulture is performed at large and small scale. Large-scale commercial horticultural production is varied, producing vegetables, fruits, and flowers on large farms or estates. The produce mainly goes to the export market, local retailers (chiefly supermarkets), and food processing companies. Fruits that are produced for export include citrus (oranges, grapefruit, lemons), subtropical fruits (bananas, mangoes, passionfruit), deciduous fruits (peaches, apricots, plums, other stone fruit, apples, and pears), and strawberries. Vegetables include cherry tomatoes, sweet corn, chilies, peas, and fine beans. These are processed and sold as packs of pre-washed mixed vegetable that are ready to cook.

Small-scale horticultural production consists of communal, resettlement A1, old resettlement, small-scale commercial farms, and peri-urban and urban producers that practice horticulture in the garden or backyards of residential stands. Smallholder farmers who have access to irrigation facilities and have sufficient water supplies during the dry season produce for the market. Most of the produce from these farmers is sold through the informal sector, while a few are contracted to supply formal markets, agro-food processing companies, and export markets.

Contract farming is another prominent production system under which both large-scale producers and small-scale farmers are engaged. Contract farming is viewed as a more profitable venture, as the returns are usually higher than selling on the local market, and there is a guaranteed market for the farmer. The companies that provide contracts are Cairns Foods, FAVCO, and Interfresh Limited, as well as retailers such as TM/Pick N Pay and Food Lovers Market. Figure A.6 shows the horticulture supply chain.

Cattle

Beef cattle are produced in all provinces, with the highest numbers produced in the dry areas. The players are large commercial farmers, small-scale commercial farmers, and communal households. Smallholder and communal farmers are mostly subsistence and place greater emphasis on the social importance of livestock. Besides farmers, the beef supply chain is integrated by input suppliers and abattoirs. See Figure A.7.

Dairy farmers can be grouped into two categories based on their production levels and the resources they own. The first category includes the dairy farmers that are registered with the National Association of Dairy Farmers (NADF) and Zimbabwe Dairy Farmers Association (ZDFA). The other group is the smallholder dairy farmers, made up of communal, small-scale, and resettlement farmers under the Agriculture and Rural Development Authority – Dairy Development Program (ARDA-DDP) and individual smallholder dairy farmers who are not in the ARDA-DDP register.

There are many associations in the dairy industry which provide technical and extension services to dairy farmers, such as the Ministry of Lands, Agriculture, and Rural Resettlement, NADF, ZDFA, ZFU, Zimbabwe Dairy Industry Trust, and the National Dairy cooperative responsible for milk collection, bulk tank supply, and sample collection for laboratory testing. The other important players in Zimbabwe's dairy industry are the input suppliers and the dairy processors such as Dairibord Zimbabwe, Kefallos, Alpha and Omega, Nestlé, and Den Dairy, to name just a few. The dairy sector also has company dairy farmers who are both producers and processors.

Poultry

The poultry industry can be divided into two main categories: commercial and indigenous free-range chicken farming. Indigenous chicken production systems are mostly based on the local scavenging domestic fowl (*Gallus domesticus*) predominant in African villages. Local chicken breeds are the most abundant livestock species in Zimbabwe. Indigenous chickens are mostly raised in a free-range system in small flocks of less than 30. They are more adapted to local conditions than the hybrid breeds but have lower productivity. The indigenous chicken production system is normally found at the subsistence level but it is very important for these household as a source of eggs and meat and a ready source of cash during a family crisis. Commercialization of indigenous chicken production is on the rise with the supply of the Boschveld breed of road runners supplied by Charles Stewart day-old chicks. However, the contribution of this sector in poultry production is still very low.

Commercial poultry production is an intensive business mainly done by individual households, small-scale producers, and large-scale commercial operators. These producers either produce broilers for meat or layers for table eggs. Irvine's, Charles Stewart, and Masvingo are some of the main suppliers of day-old chicks for both layers and broilers. There are many abattoirs and processors that sometimes add value by processing and producing chicken byproducts. Feed suppliers and veterinary distributors are very critical in chicken production.

Notes

1. SNV (2016).
2. Tongaat-Hulett, a South African sugar company, owns 100 percent of the Triangle Sugar Estate and about 50.3 percent of the Hippo Valley Estate. Hippo Valley Estate is a public company listed on the Zimbabwe Stock Exchange, and other shareholders include Tate & Lyle and the British Agro-Company.

Figure A.6. Horticulture Supply Chain

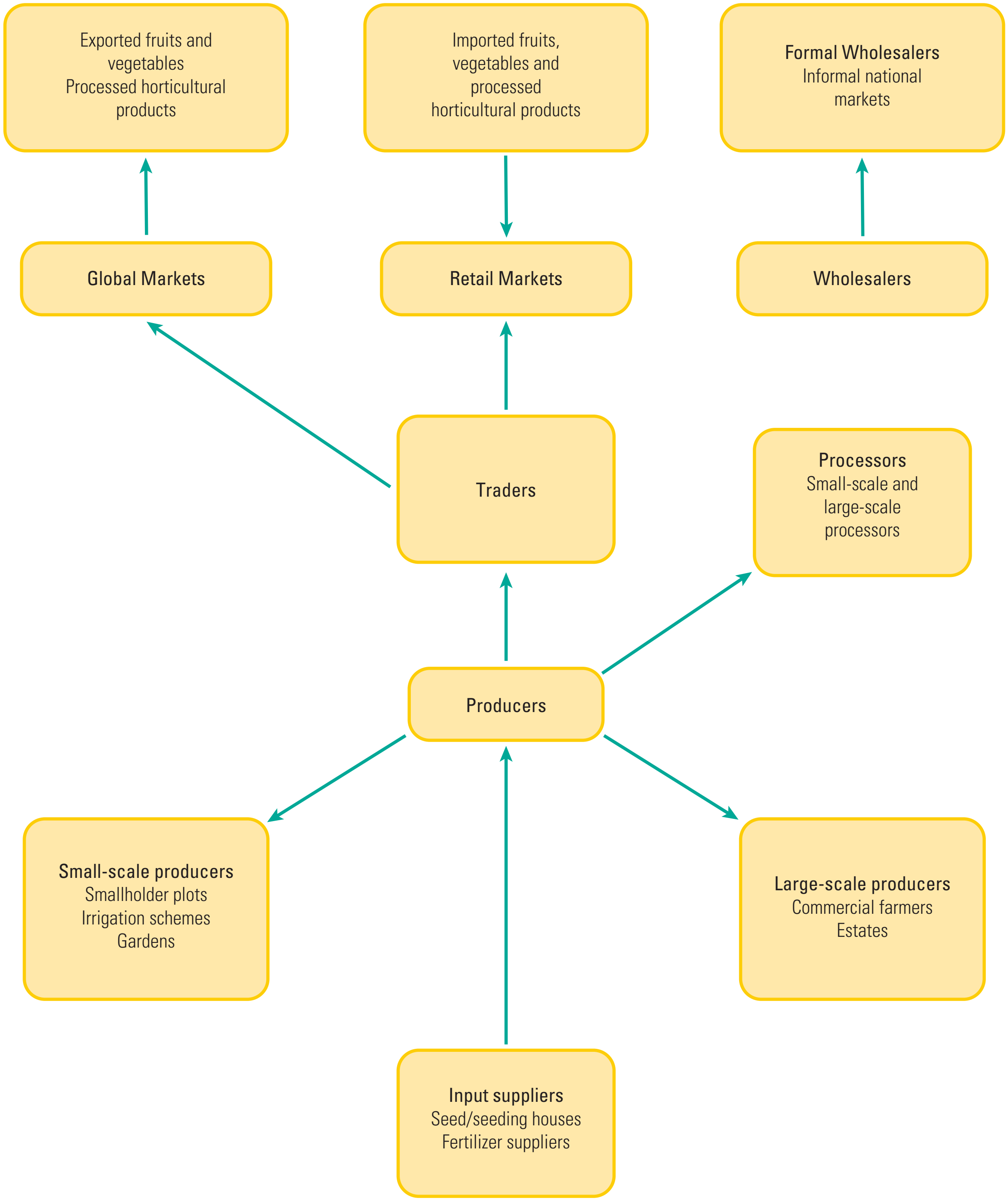
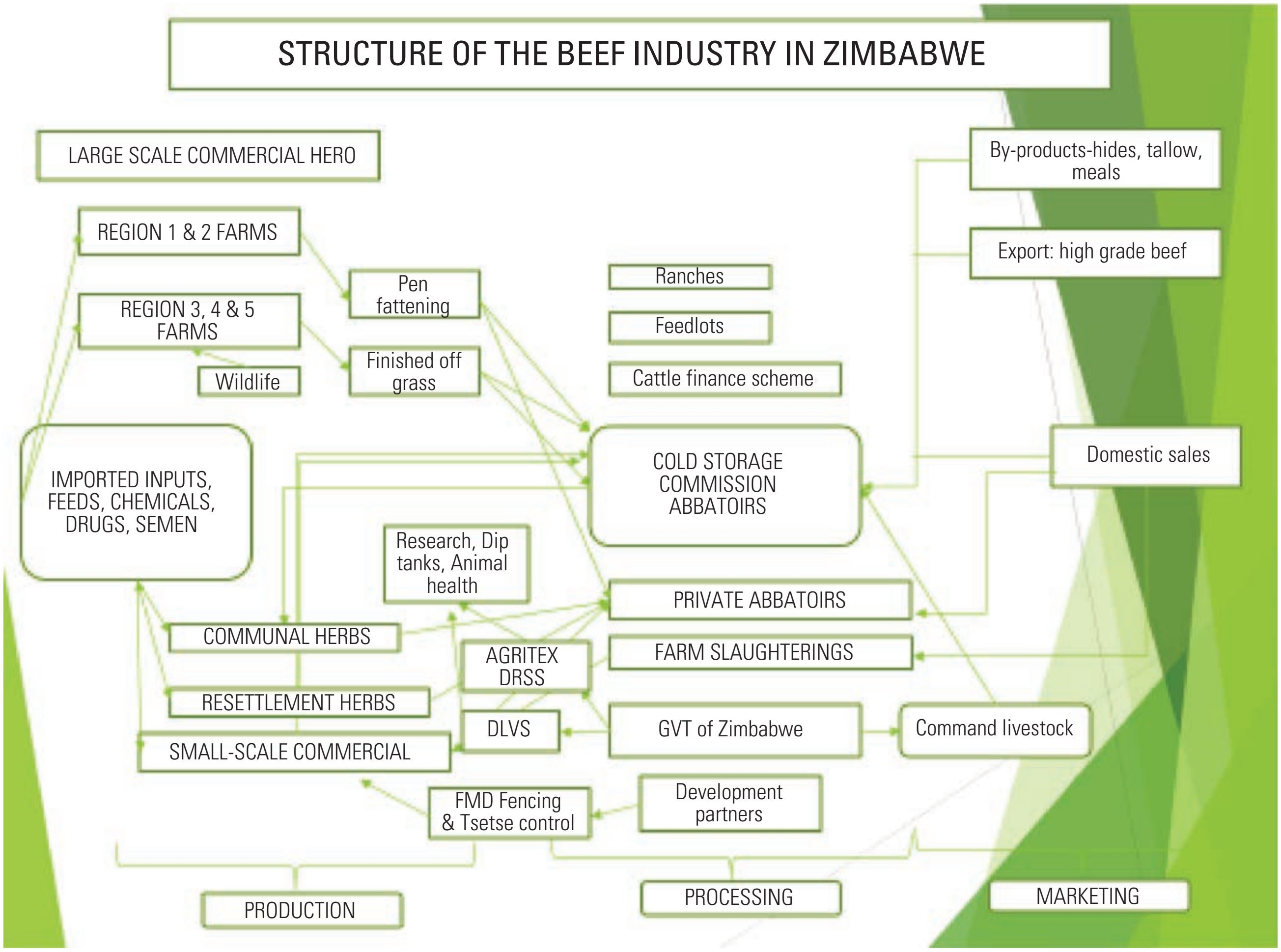


Figure A.7. Beef Supply Chain



APPENDIX B

METHODOLOGY USED TO ESTIMATE THE VALUE OF CROP LOSSES

Yield deviations are calculated with respect to the trend line of the yields; those years in which the negative deviations are greater in absolute value than the standard deviation of the deviations are taken as the years in which significant risk events occur. Then, for those years, the deviations from the trend are multiplied by the area. This algorithm make it possible to estimate the volume of production losses. Losses in value are then calculated by multiplying the volume of losses by the price of crops. The sections that follow present examples of these calculations for tobacco and maize. See also Tables B.1 and B.2 and Figures B.1-B.3.

Tobacco Crop Loss Estimates

Table B.1. Data for Estimating Tobacco Crop Losses and Their Value

Year	Area (ha)	Yields (t/ha)	US$/kg	Trend of yields (t/ha)	Deviation of yields with respect to yield trend - D (t/ha)	Trend of D - Standard deviation of D (t/ha)	Losses (t)	Losses (US$ at 2014 prices)
1985	52,464	2.012		2.34	–0.33	–0.54	0	0
1986	57,349	1.993		2.31	–0.32	–0.54	0	0
1987	63,536	2.015		2.28	–0.27	–0.54	0	0
1988	59,178	2.026		2.26	–0.23	–0.54	0	0
1989	57,660	2.254		2.23	0.03	–0.54	0	0
1990	59,425	2.253		2.20	0.05	–0.54	0	0
1991	66,927	2.542		2.17	0.37	–0.54	0	0
1992	80,070	2.512	1.62	2.14	0.37	–0.54	0	0
1993	82,900	2.634	1.24	2.12	0.52	–0.54	0	0
1994	67,416	2.51	1.73	2.09	0.42	–0.54	0	0
1995	74,550	2.666	2.12	2.06	0.61	–0.54	0	0
1996	81,231	0.481	2.94	2.03	–1.55	–0.54	126,035	399,472,981
1997	90,630	1.893	2.33	2.00	–0.11	–0.54	0	0
1998	91,905	2.349	1.72	1.98	0.37	–0.54	0	0
1999	84,762	2.267	1.74	1.95	0.32	–0.54	0	0
2000	84,857	2.792	1.69	1.92	0.87	–0.54	0	0
2001	76,017	2.664	1.75	1.89	0.77	–0.54	0	0
2002	74,295	2.213	2.27	1.87	0.35	–0.54	0	0
2003	49,571	1.673	2.25	1.84	–0.16	–0.54	0	0
2004	44,025	1.565	2	1.81	–0.24	–0.54	0	0
2005	57,511	1.3	1.61	1.78	–0.48	–0.54	0	0
2006	58,808	0.943	2	1.75	–0.81	–0.54	47,683	151,131,657
2007	54,551	1.339	2.31602	1.73	–0.39	–0.54	0	0
2008	61,622	0.792	3.21196	1.70	–0.91	–0.54	55,834	176,967,160
2009	62,737	0.934	2.97859	1.67	–0.74	–0.54	46,187	146,390,111
2010	67,054	1.842	2.87904	1.64	0.20	–0.54	0	0

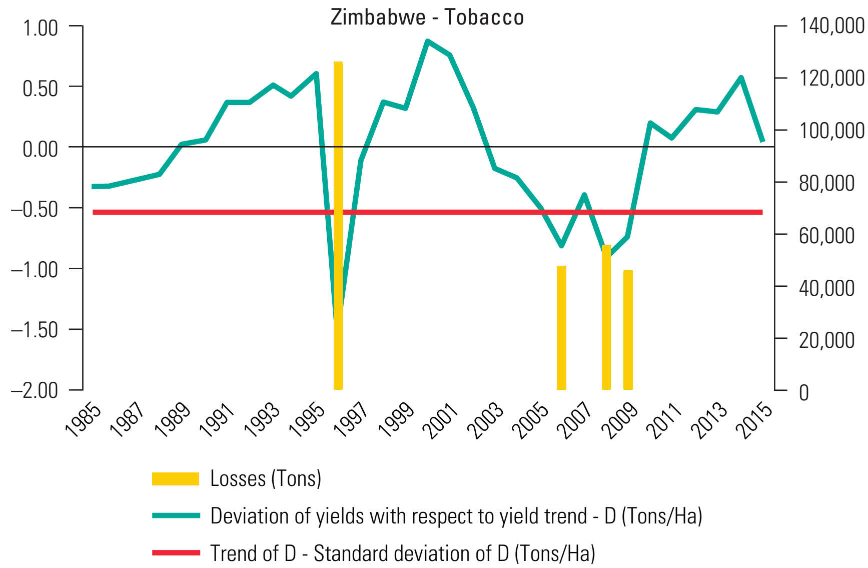
(Table continues next page)

Table B.1. *(continued)*

Year	Area (ha)	Yields (t/ha)	US$/kg	Trend of yields (t/ha)	Deviation of yields with respect to yield trend - D (t/ha)	Trend of D - Standard deviation of D (t/ha)	Losses (t)	Losses (US$ at 2014 prices)
2011	78,415	1.689	2.72932	1.61	0.07	–0.54	0	0
2012	76,359	1.893	3.65099	1.59	0.31	–0.54	0	0
2013	88,627	1.852	3.6749	1.56	0.29	–0.54	0	0
2014	107,371	2.104	3.1695	1.53	0.57	–0.54	0	0
2015	108,307	1.551	4.29746	1.50	0.05	–0.54	0	0

Source: Tobacco Industry Marketing Board (2015); Ministry of Agriculture, Mechanization and Irrigation Development, Zimbabwe, Agricultural Statistical Bulletin (2016).

Figure B.1. Yield Trends and Crop Losses, Tobacco



Maize Crop Loss Estimates

Table B.2. Data for Estimating Maize Crop Losses and Their Value

Year	Production (t)	Area (ha)	Trend of yields (t/ha)	NATIONAL - Deviation of yields with respect to yield trend - D (t/ha)	NATIONAL - Trend of D - Standard deviation of D (t/ha)	Losses (t)	Losses (US$ at 2016 prices) (1)
1986/87	1,530,000	774,800	1.61	0.367410753	–0.332851207	0	0
1987/88	2,253,100	1,299,500	1.57	0.166536448	–0.332851207	0	0
1988/89	1,931,200	1,198,300	1.53	0.084662143	–0.332851207	0	0
1989/90	1,993,800	1,149,800	1.49	0.246787838	–0.332851207	0	0
1990/91	1,585,800	1,101,200	1.45	–0.007086466	–0.332851207	0	0
1991/92	361,000	881,000	1.41	–0.996960771	–0.332851207	878,322	342,545,751
1992/93	2,011,850	1,238,000	1.37	0.258164924	–0.332851207	0	0
1993/94	2,326,000	1,401,200	1.33	0.333290619	–0.332851207	0	0
1994/95	839,600	1,397,900	1.29	–0.685583686	–0.332851207	958,377	373,767,199
1995/96	2,609,000	1,535,000	1.25	0.45354201	–0.332851207	0	0
1996/97	2,191,370	1,640,100	1.21	0.129667705	–0.332851207	0	0
1997/98	1,418,030	1,223,800	1.17	–0.0072066	–0.332851207	0	0
1998/99	1,519,560	1,446,400	1.13	–0.075080905	–0.332851207	0	0
1999/00	1,619,651	1,373,117	1.09	0.094044791	–0.332851207	0	0
2000/01	1,526,328	1,239,988	1.05	0.185170486	–0.332851207	0	0
2001/02	604,758	1,327,854	1.01	–0.550703819	–0.332851207	731,254	285,189,165
2002/03	1,058,786	1,352,368	0.97	–0.182578124	–0.332851207	0	0
2003/04	1,686,151	1,493,810	0.93	0.203547571	–0.332851207	0	0
2004/05	915,366	1,729,867	0.89	–0.356326733	–0.332851207	616,398	240,395,164
2005/06	1,484,839	1,712,999	0.85	0.021798962	–0.332851207	0	0
2006/07	952,600	1,445,800	0.81	–0.146075343	–0.332851207	0	0
2007/08	470,700	1,722,322	0.76	–0.494949648	–0.332851207	852,463	332,460,440
2008/09	1,242,566	1,521,780	0.72	0.085176047	–0.332851207	0	0
2009/10	1,327,572	1,803,542	0.68	0.015301743	–0.332851207	0	0
2010/11	1,451,629	2,096,034	0.64	0.048427438	–0.332851207	0	0
2011/12	968,041	1,689,786	0.60	0.395553133	–0.332851207	0	0
2012/13	798,596	1,265,236	0.56	0.065678828	–0.332851207	0	0
2013/14	1,456,153	1,655,366	0.52	0.355804524	–0.332851207	0	0
2014/15	742,225	1,531,663	0.48	–0.004069781	–0.332851207	0	0
2015/16	511,816	1,161,997	0.44	–0.003944086	–0.332851207	0	0

Source: MAMID Agricultural Statistical Bulletin, 2016.
Note 1: Resettlement Areas included in Communal Area Totals from 1980/81 onwards, Small-scale A2 Totals in A2 Area Totals from 1985/2013.
(1) Maize retail price, national average, June 2016 US$/kg 0.39. Source: FAO/GIEWS.

Figure B.2. Yield Trends and Crop Losses in Relation to Severe Weather Events, Maize

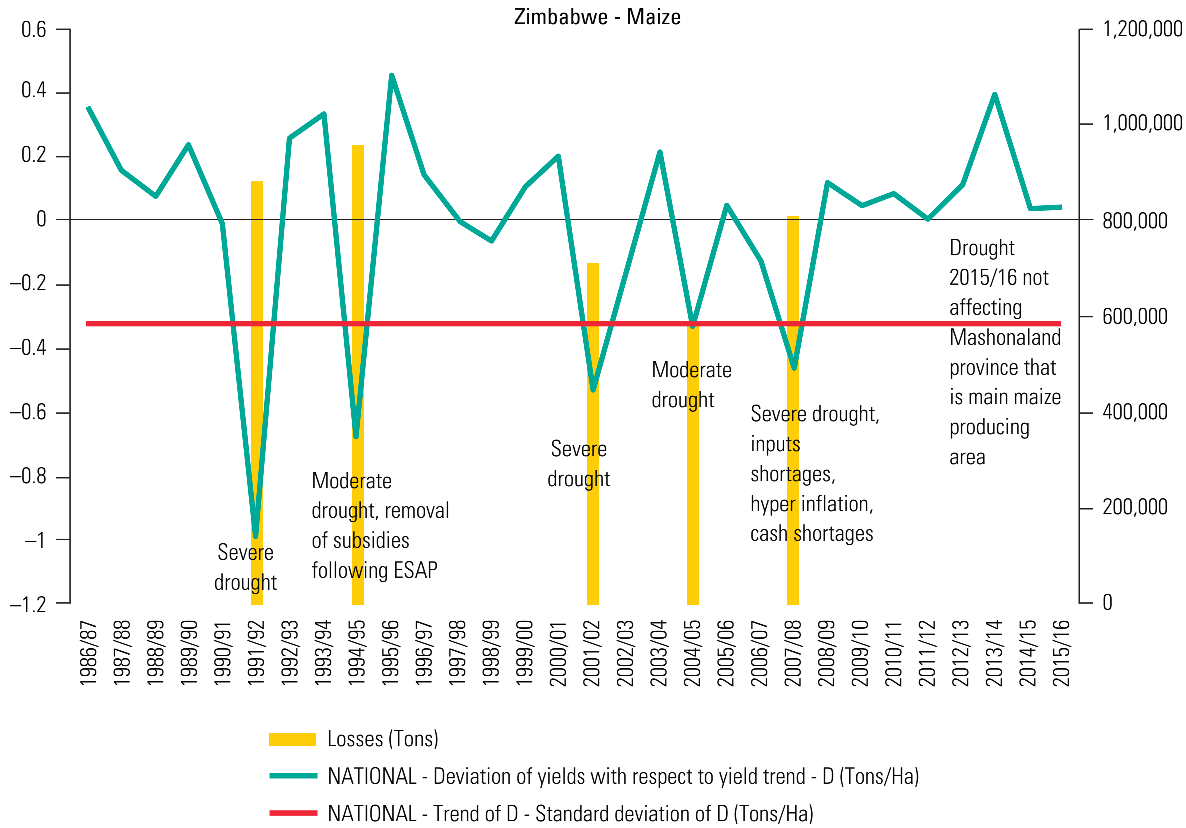
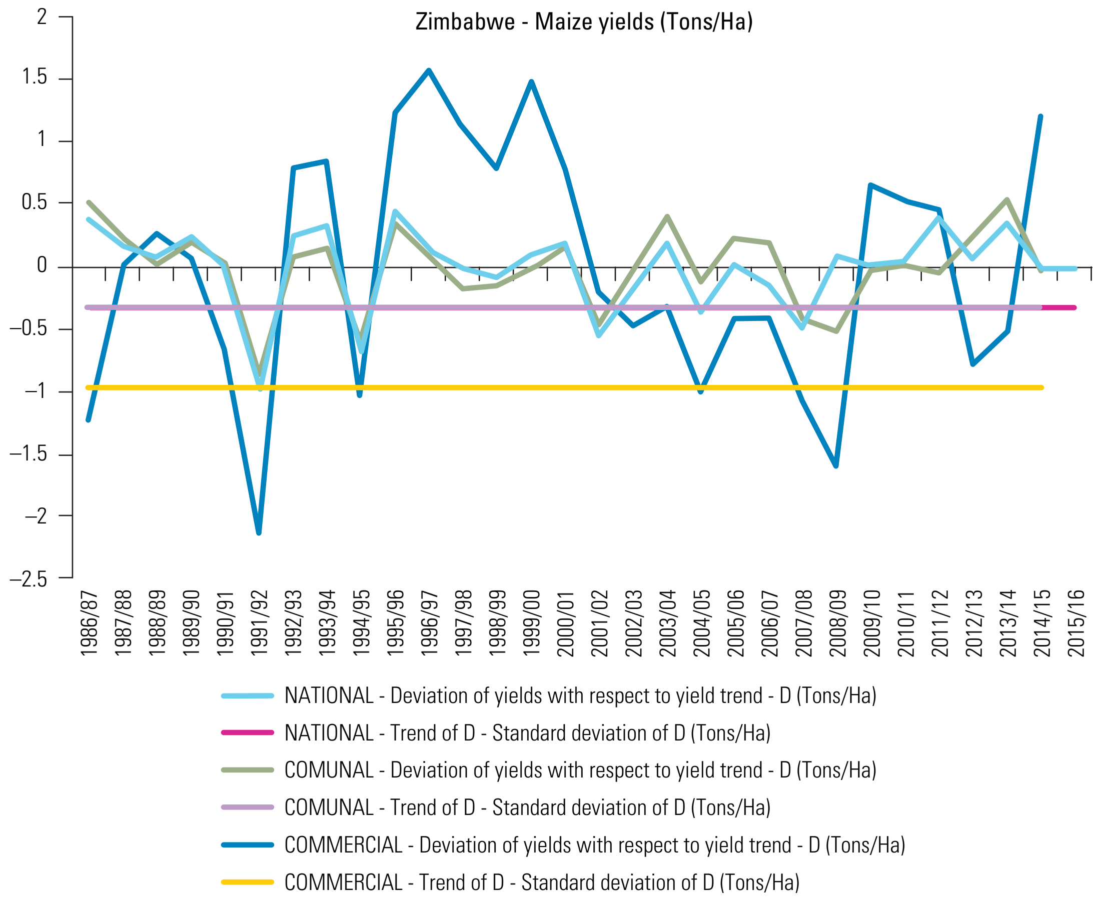


Figure B.3. Maize Yields Over Time (National Yields and Yields at Different Scales of Production)



→ Approximately US$81.6 million at 2015/16 prices, or 4.9 percent of the agricultural GDP, was estimated as the value of the average production loss annually. For the moment, the calculation involves tobacco and maize, but these two crops account for about 47 percent of total agricultural GDP.

APPENDIX C

METHODOLOGY FOR THE RISK ASSESSMENT FOR VARIOUS RETURN PERIODS

Materials and Methods

The crop risk assessment is performed for coffee, cotton, groundnuts, maize, sorghum, soybeans, sugarcane, tobacco, and wheat in the aggregate for all of Zimbabwe. The analysis covers the period from 1986 to 2015. The food crop risk assessment was largely based on official records from MAMID and FAOSTAT. This information was complemented with data on the average price at the province level for 2016 for the main food crops, also provided by MAMID.

The main outputs of the crop risk assessment model are the Expected Average Loss and the Loss at Risk. The Expected Average Loss for each crop is calculated based on the deviation of Monte Carlo-generated actual gross value of production (GVP) from expected GVP. If the Monte Carlo-generated actual GVP falls short of the expected GVP, then there is a loss proportional to the size of the shortfall. For the purposes of this model, the Expected Average Loss for a given unit is determined by the average of the Monte Carlo GVP shortfalls with respect to the expected GVP.

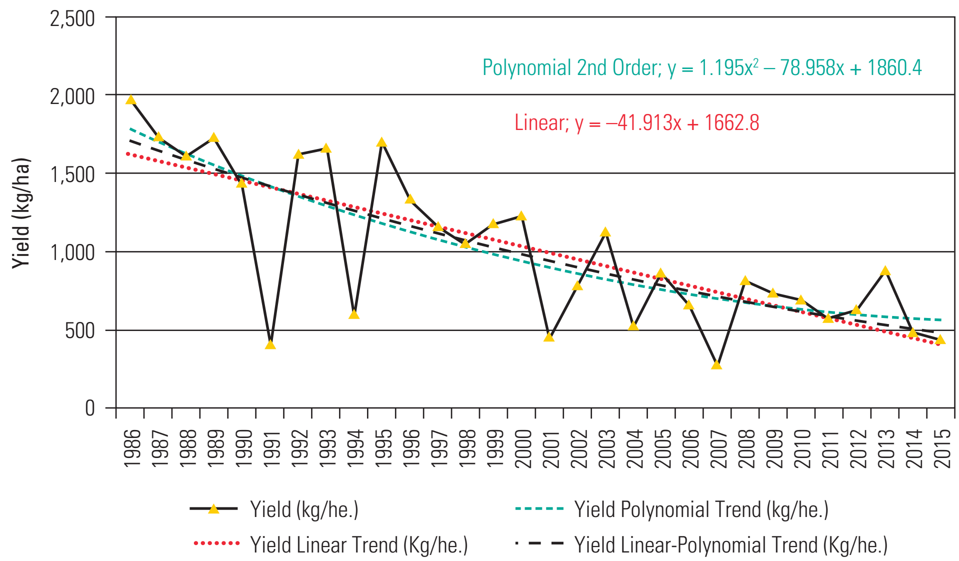
The Loss at Risk (LaR) or Probable Maximum Loss (PML) is a key measure used to infer the potential losses in the portfolio. The LaR is a percentile of the loss distribution, calculated in function of the probability of occurrence of a catastrophic event. For example, the LaR for an Exceedance Probability "p" of 1 percent (or return period "RP" of 1 in 100 years), is the value of the loss distribution that accumulates 99 percent of probability, i.e., the 99th percentile. For the purposes of this model, the Loss at Risk for a given Unit is determined by the percentile of the Monte Carlo GVP shortfalls with respect to the Expected GVP associated with a given probability that is related to a return period.

Cropped area, total production, and yield records obtained from MAMID and FAOSTAT are treated prior to use in the analysis. Crop area and yield records are treated for outliers. Outliers were identified by setting an upper bound and a lower bound for the records, and all records that fell outside of these boundaries were removed. For this analysis, the upper bound was set at average value for the variable plus 3.5 times its standard deviation, and the lower bound was set at the average value for the variable less 3.5 times its standard deviation.

Crop yield series are detrended to remove the effects of shifts in yields along the series. For the purposes of detrending yields, a combination based on the average between a linear detrending and a polynomial of second-order function is used for each crop.

The correlations among the different crops were considered in the simulation model for the aggregate portfolio, using a Pearson model. The correlations were added to the model by using the RiskCorrmat Function; RiskCorrmat functions are added to each of the input distribution functions that are included in defined correlation matrix. The historical burning cost (HBCA) was calculated for the different coverage levels from 100 percent down to 30 percent for each crop. The HBCA for each unit area of insurance (UAI), and coverage levels were then fit to a set of continuous probability density functions conformed by a Normal, Lognormal, Weibull, Loglogistic, Gamma, and inverse Gaussian probability density function. The first selection criterion was based on the minimization of the root mean square error (RMSE). In addition to the

Figure C.1. Zimbabwe: Historic Evolution of Maize Yields



RMSE, probability density functions were also tested against other critical criteria.

The detrending analysis comes from a weighted average of a linear detrending and a polynomial of second order detrending. Both show a similar trend. The period considered for the detrending comprised the full series (1986–2016). The land reform and the changes in property rights at the begging of the 2000s had a severe impact on agriculture output. The land reform issue and its impact on the interpretation of the results of this analysis are highlighted in the main text of this report as a factor to be considered when interpreting the results, along with the additional consideration that during 2001-08 Zimbabwe experienced successive seasons of drought followed by one season of excessive rainfall, as well as deregulation that led to production increases. It is not possible to distinguish the impacts of each of these circumstances on yields, so it was decided that the analysis would use the entire data series but that the results must be interpreted with caution. Figure C.1 shows the evolution and trends in maize yields in Zimbabwe.

The second phase of the detrending analysis is to estimate the yield variability. For that purpose, the percentage deviations (YPD) between the actual yields with respect to the corresponding expected yield according to the trend line is also calculated. Figure C.2 presents the time series of YPD for maize in Zimbabwe.

YPDs are then applied to the expected yield (EY). The EY is calculated as the projection of the of the average between a polynomial of second order detrending function and a linear detrending function. As a result, an adjusted detrended yield is obtained. Figure C.3 shows the detrended yields for maize in Zimbabwe, alongside EY for 2016.

In the next step the stochastic variable of the model (i.e., YPD) is fitted to a parametric probability distribution function (PDF). This procedure is done for each crop in the portfolio. Each fit is then tested against three criteria: (1) Chi-squared, (2) Anderson-Darling, and (3) Kolmogorov-Smirnov. Figure C.4 shows the resulting (detrended) yield PDF for maize in Zimbabwe.

Once the PDFs are fitted to the historical YPD data for each crop and the correlation matrix among YPD samples is calculated, the simulation can be performed. In this case, a Monte Carlo simulation was used to generate simulated samples of 10,000 hypothetical years of detrended yields for the crops included in the portfolio.

The valuation of the crops for the calculation of the GVP is based on the average price for 2016 for the main crops in Zimbabwe (provided by MAMID). The stochastic GVP used as basis for the calculation of the Expected Average Loss, and the Loss at Risk is the result of the multiplication of each of the Monte Carlo-generated deviation from expected crop area (EHA), times the Monte Carlo-generated deviation from yield (YPD) times the corresponding Expected Yield for 2017, times the average price for the crop provided by MAMID.

Figure C.2. Zimbabwe: Maize Yield Deviations from Expected Yields

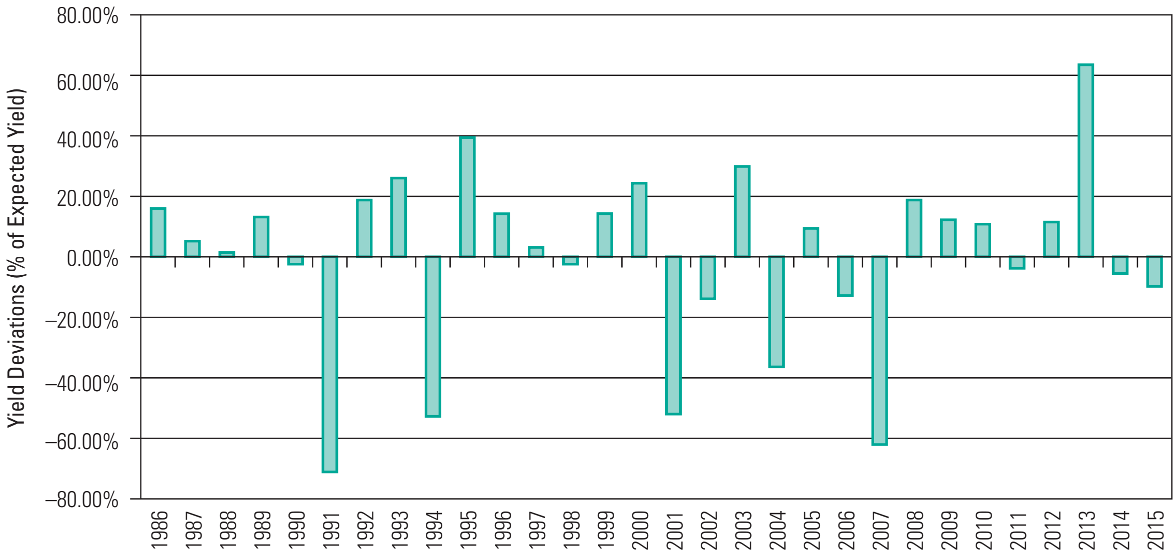


Figure C.3. Zimbabwe: Detrended Maize Yields

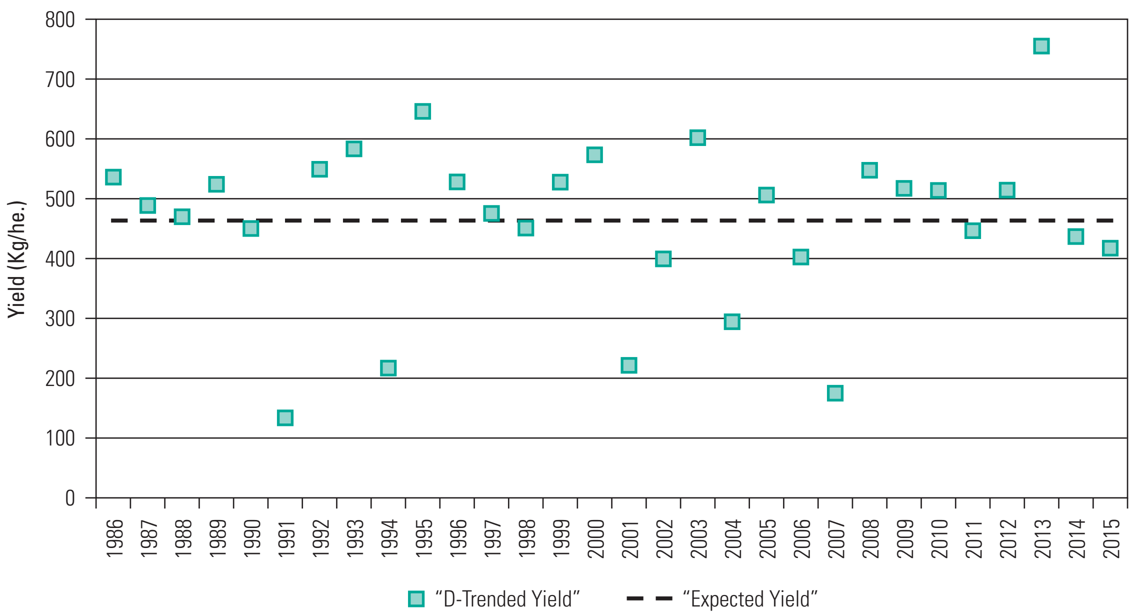
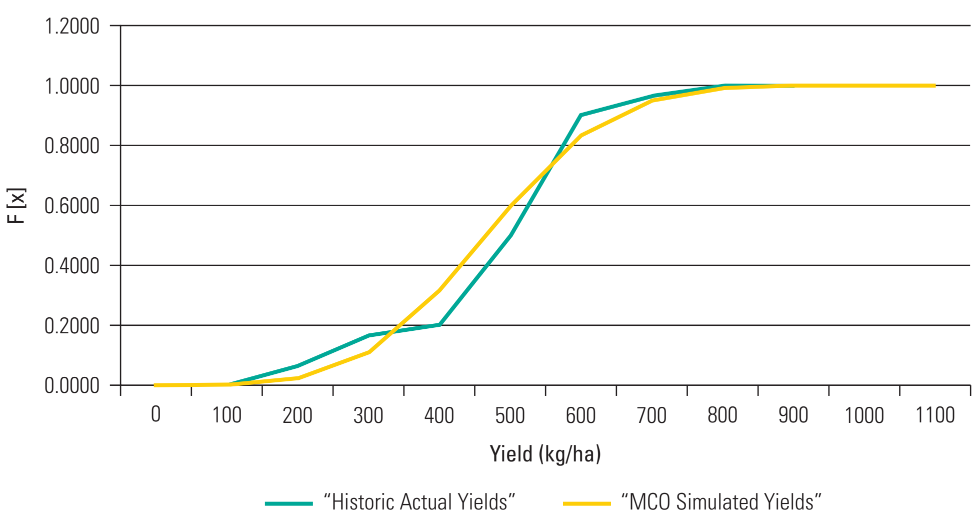


Figure C.4. Zimbabwe Maize: Best Fit Probability Distribution Function over Detrended Yields



By using this methodology , 10,000 hypothetical years of detrended GVP for the crops and provinces included in the portfolio were obtained. These values were used as the main underlying data for the risk assessment model used in the study. Figure C.5 presents the schematic description of the methodology followed for obtaining the 10,000 hypothetical years of detrended GVP for maize. The figure conceptually shows how detrended Monte Carlo yields are generated and how the 10,000 hypothetical years of detrended GVP are determined.

Main Findings and Discussion

This section presents the aggregate risk assessment for the whole crop portfolio in Zimbabwe. The findings are the result of the Crop Risk Assessment Tool that was specifically designed for this study.

Crop Portfolio Risk Assessment

Total area planted to the main crops in Zimbabwe is 2.25 million hectares. The exposure of main crops in terms of GVP amounts to US$945 million. Tobacco and maize, accounting for 38 percent and 28 percent of the total exposure, are the main crops in the portfolio. Sugarcane with US$177 million in exposure is also a very important crop that accounts for 19 percent of the total crop exposure. Table C.1 presents data on the area and GVP of the crops in the portfolio analyzed for Zimbabwe.

Agricultural production has shown a steady downtrend over the last 30 years in Zimbabwe. Market analysts and academic researchers often attribute this decline in agricultural output to the 2000 reform that resulted in a significant number of smallholder farms without the skills and ability to efficiently produce agricultural crops compared to the previously large-scale commercial farms. Figures C.6 and C.7 depict the declines in production and yields.

Agricultural production in Zimbabwe is very volatile. The average value of losses for the main crops in Zimbabwe is calculated at US$125.7 million per year and accounts for 13.30 percent of the portfolio GVP. Severe agricultural production losses may recur at relatively short intervals in Zimbabwe. The LaR indicates that the food crop portfolio may face a loss equivalent to 27.2 percent of the national crop GVP (or US$256.7 million) once in 10 years, crop losses of 39.9 percent of national GVP (or US$377.3 million) once in 100 years, and crop losses of 44.23 percent of GVP (US$417.9 million) once in 250 years. Table C.2 and Figure C.8 present the expected LaR values for the crop portfolio in Zimbabwe.

Soybeans make the highest contribution to risk in the food crop portfolio in Zimbabwe. The share of soybeans in the portfolio's average loss cost increased by 1.49 points for each additional point of increase of its share in the portfolio. On the other hand, sugarcane is the crop that shows the lowest contribution to the risk in the portfolio. For each basis point the share of sugarcane crop is increased, its contribution to the portfolio's average loss cost is increased only by 0.52 basis points. Table C.3 shows the contribution of each crop to the average loss cost in the portfolio.

Maize Crop Risk Assessment

Maize is the staple crop in Zimbabwe, used for household consumption and income generation. Data from MAMID show that maize production and yields in Zimbabwe steadily declined over the last 30 years. Currently there are 1.45 million hectares sown with maize in Zimbabwe. The GVP for maize, according to the assumptions of this risk assessment, is US$261.4 million. Figures C.9 and C.10 show the decline in maize production and yields for the period from 1986 to 2015.

Maize seems to be a medium-risk crop in Zimbabwe. The average loss cost for maize crops is 11.38 percent of its GVP or US$29.7 million per year. The LaR analysis indicates that maize may face a loss equivalent to 66.4 percent of the national GVP (or US$173.5 million) once in 100 years or a loss of 75.3 percent of national GVP (or US$197 millions) in a 250-year return period. Table C.4 and Figure C.11 show the expected LaR values for maize in Zimbabwe.

Tobacco Crop Risk Assessment

Zimbabwe is the largest grower of tobacco in Africa, and the sixth-largest grower in the world. Three types of tobacco have traditionally been grown in the country: Virginia flue-cured, burley, and oriental tobacco. Over 95 percent of Zimbabwe's tobacco consists of flue-cured tobacco, which is renowned for its flavor. In 2005, 54 percent of Zimbabwe's tobacco was exported to China.

Land reform in Zimbabwe after 2000 redistributed land to farmers unskilled in growing tobacco. These farmers held no title to the land, so they lacked the

Figure C.5. Methodology Used for the Assessment

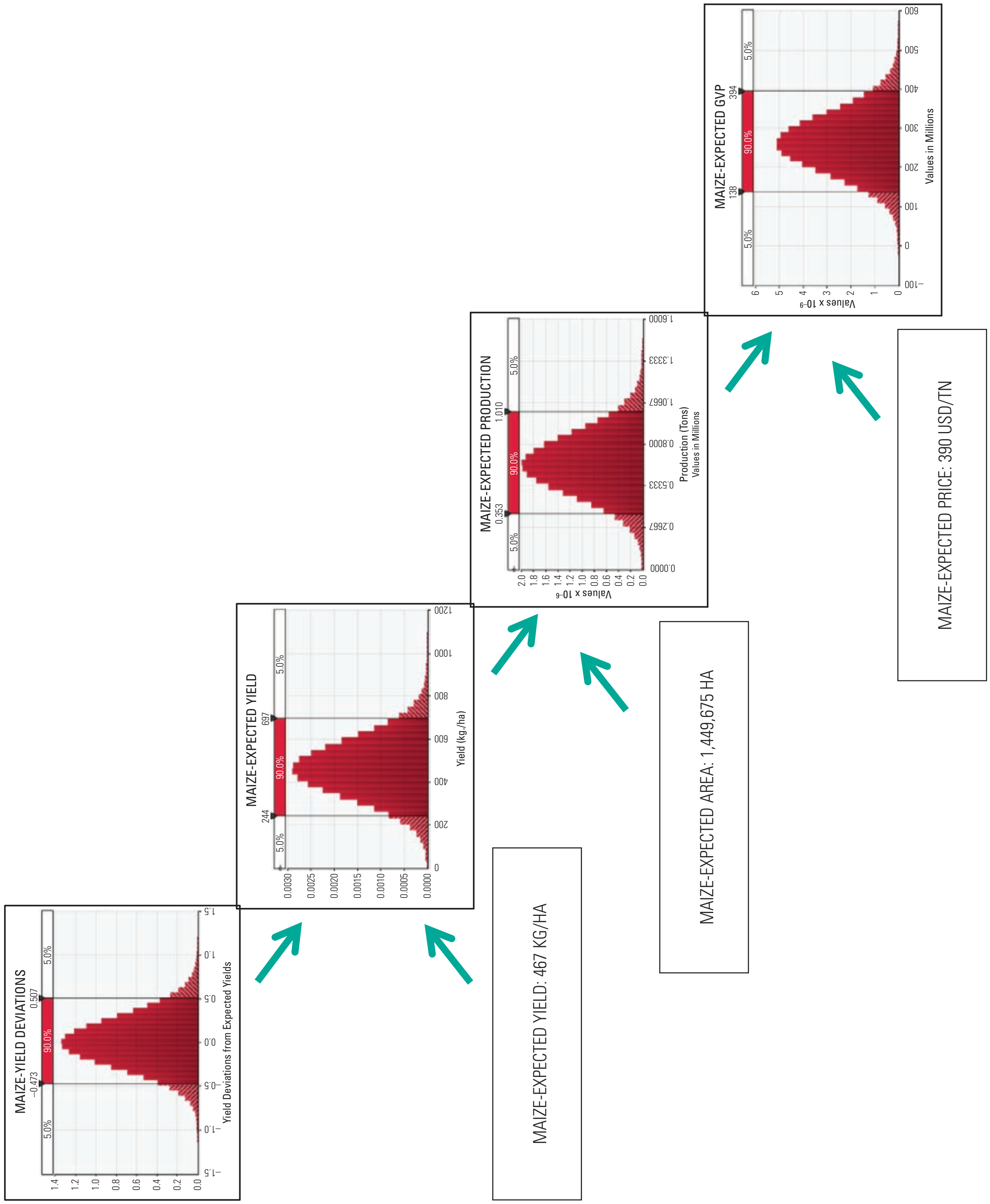


Table C.1. Zimbabwe Crop Portfolio: Exposure–Expected Gross Value of Production (US$)

Unit	Expected crop area (ha)	Expected yield (kg/ha)	Expected production (t)	Crop price (US$/kg)	Exposure - GVP (US$)
Cotton	149,955	501	75,111	0.500	37,555,732.20
Coffee	2,225	28	63	3.500	218,839.16
Groundnuts	229,510	379	87,097	0.500	43,548,624.55
Maize	1,449,675	462	670,159	0.390	261,362,150.45
Sorghum	224,420	226	50,723	0.379	19,223,947.97
Soybean	47,919	995	47,701	0.480	22,896,717.10
Sugarcane	44,273	72,737	3,220,327	0.055	177,117,978.76
Tobacco	101,435	1,450	147,067	2.440	358,844,578.46
Wheat	14,552	3,249	47,280	0.510	24,112,738.10
Total	***2,263,966***				***944,881,306.75***

collateral to obtain bank loans .Much of Zimbabwe's farmland went out of cultivation, and the tobacco crop bottomed out at 48 million kilograms in 2008, just 21 percent of the 2000 crop. A contract system for tobacco farming was introduced in Zimbabwe in 2005. Buyers like British American Tobacco began to contract with tobacco farmers to buy their entire crop at the end of the season. In return, the buyer would supply the farmer with all necessary inputs. Buyers also took greater responsibility for the crop, sending agronomists to the contracted fields to advise farmers on agricultural techniques and make sure that tobacco workers were paid on time. China also began to invest in the tobacco industry. The entry of international players in the local market improved contract terms and drove up sales prices. Tobacco production recovered under the contract system. The 2014 tobacco crop of 217 million kilograms was the third-largest crop on record, amounting to 104 percent of the average crop grown from 1991 to 2000. The structure of the industry has been transformed: in 2000, 1,500 large-scale tobacco farmers grew 97 percent of the crop, and in 2013, 110,000 small-scale farmers grew 65 percent of the crop.

Currently more than 101,000 hectares are planted with tobacco, which is the crop with the highest value in Zimbabwe. The GVP of tobacco in Zimbabwe is

Figure C.6. Zimbabwe: Production of Main Crops (t), 1986–2015

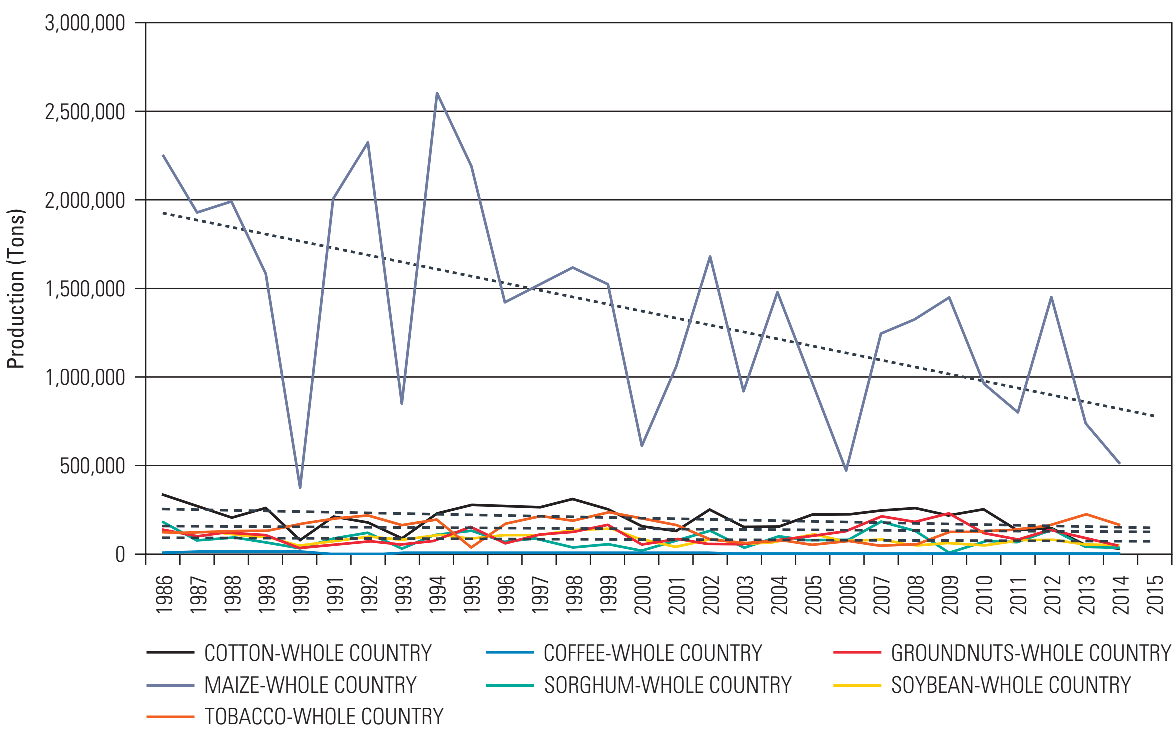


Figure C.7. Zimbabwe: Yields of Main Crops (kg/ha), 1986–2015

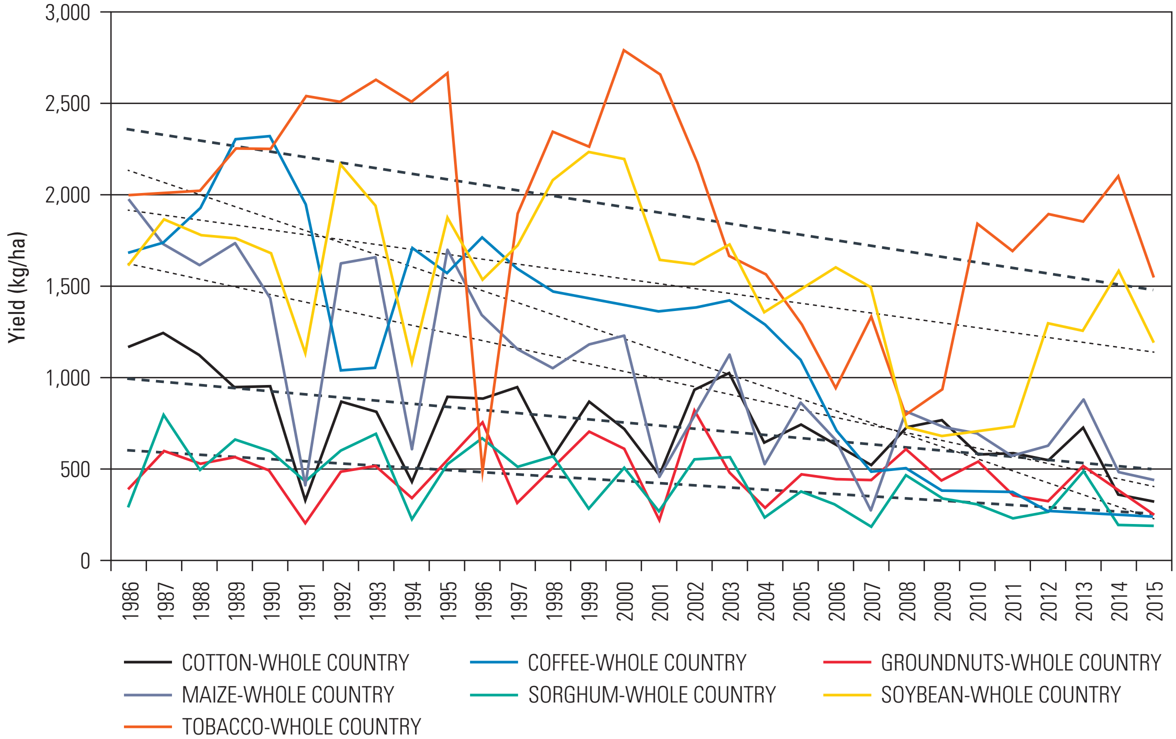


Table C.2. Zimbabwe: Whole Crop Complex: Expected LaR Values for Different Return Periods

Recurrence (years)	10	25	50	100	150	200	250	500
LaR (% exposure)	27.17%	32.94%	36.28%	39.93%	41.77%	42.92%	44.23%	46.67%
LaR (US$ millions)	256.7	311.2	342.8	377.3	394.7	405.6	417.9	441.0

Figure C.8. Expected LaR for Different Recurrence Periods for the Whole Crop Portfolio in Zimbabwe

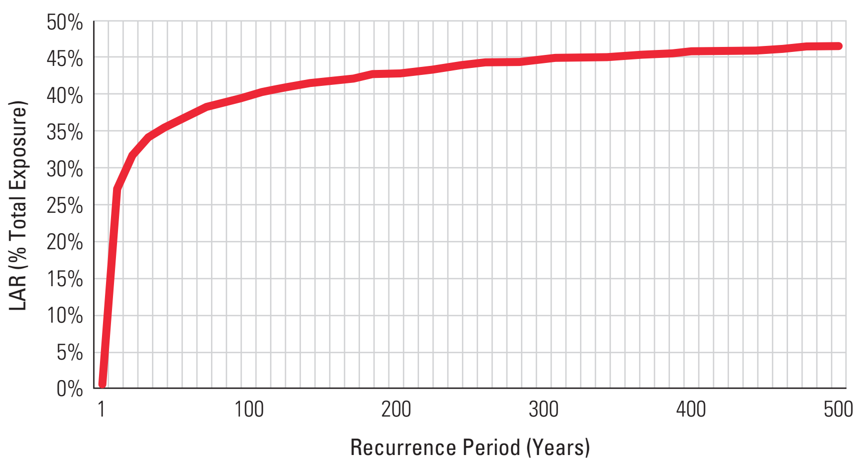


Table C.3. Zimbabwe: Contribution of Each Crop to the Portfolio Risk

Portfolio	Exposure – GVP (US$)	%	Average loss cost (US$ millions)	%	Contribution index
Cotton	37,555,732.20	3.97%	3,664,559.08	2.92%	0.73
Coffee	218,839.16	0.02%	44,584.49	0.04%	1.53
Groundnuts	43,548,624.55	4.61%	3,855,844.93	3.07%	0.67
Maize	261,362,150.45	27.66%	29,734,159.05	23.66%	0.86
Sorghum	19,223,947.97	2.03%	2,593,313.49	2.06%	1.01
Soybeans	22,896,717.10	2.42%	4,539,173.82	3.61%	1.49
Sugarcane	177,117,978.76	18.74%	12,304,014.98	9.79%	0.52
Tobacco	358,844,578.46	37.98%	65,377,385.611	52.02%	1.37
Wheat	24,112,738.10	2.55%	3,554,433.49	2.83%	1.11
Whole portfolio	***944,881,306.75***	***100.0%***	***125,667,468.94***	***100.0%***	***1.00***

Figure C.9. Zimbabwe: Maize Production (t), 1986–2015

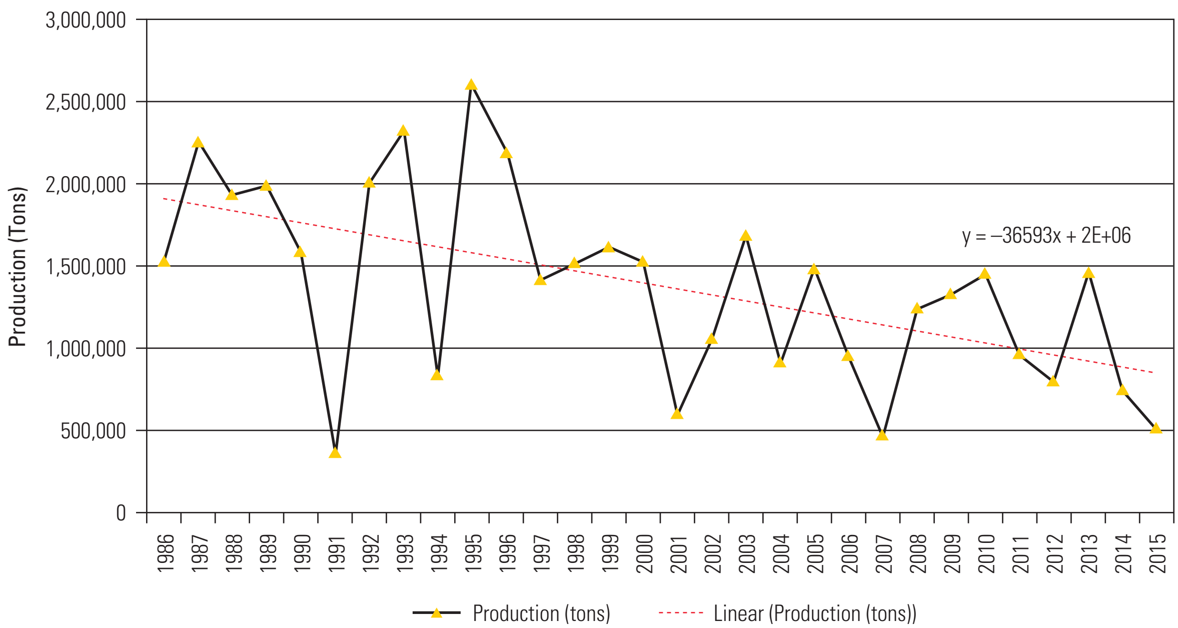


Figure C.10. Zimbabwe: Maize Yields (kg/ha), 1986–2015

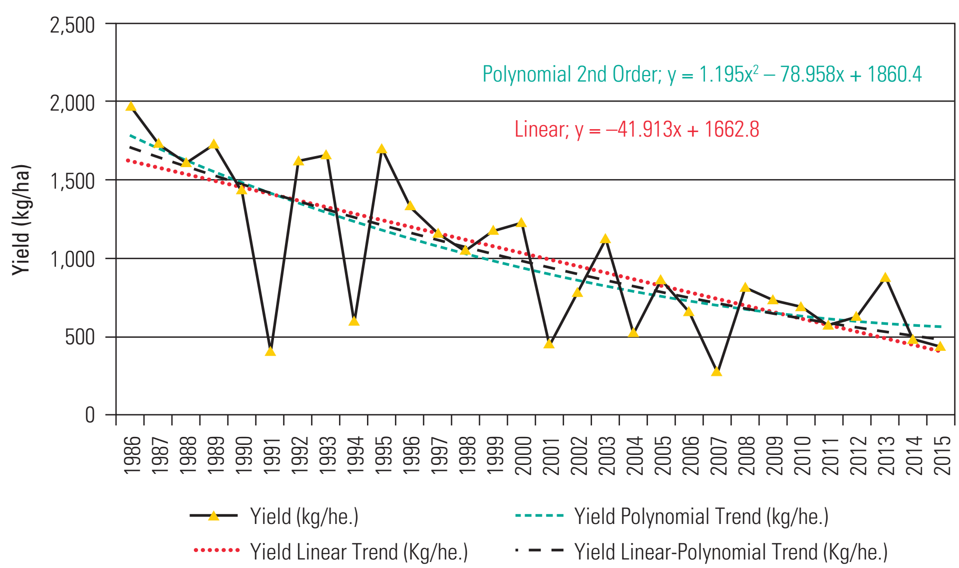
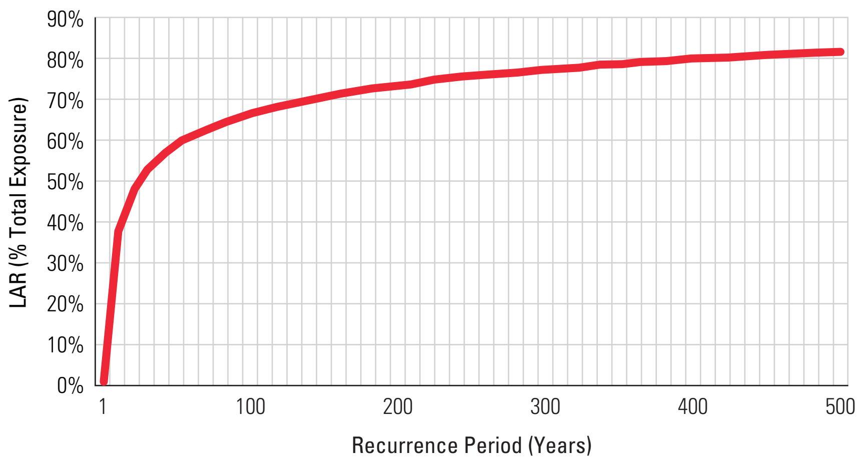


Table C.4. Zimbabwe: Expected LaR Values for Maize for Different Return Periods

Recurrence (years)	10	25	50	100	150	200	250	500
LaR (% exposure)	36.87%	50.26%	58.78%	66.40%	70.47%	73.32%	75.34%	81.58%
LaR (US$ millions)	96.4	131.4	153.6	173.5	184.2	191.6	196.9	213.2

Figure C.11. Zimbabwe: Expected LaR for Maize for Different Recurrence Periods



estimated at US$359 million. Tobacco risk exposure accounts for 38 percent of the total crop risk exposure in the country. Figures C.12 and C.13 show the evolution of tobacco production and yields over 1986–2015.

Tobacco in Zimbabwe is affected by drought and hailstorms. Drought can be especially pervasive during ENSO years. Hailstorms are quite frequent in Zimbabwe, and hail damage affects tobacco production as well as the quality of the product.

Tobacco production is a high-risk endeavor in Zimbabwe. The expected average loss for tobacco in Zimbabwe accounts for 18.22 percent of its GVP or US$65.3 million per year. The expected LaR for this crop is 66.7 percent of the GVP (US$239.4 million) for a recurrence period of 100 years and 70.38 percent of GVP (US$252.6 million) for a recurrence period of 250 years. Table C.5 and Figure C.14 show the expected LaR values for tobacco for different return periods.

Figure C.12. Zimbabwe: Tobacco Production (t), 1986–2015

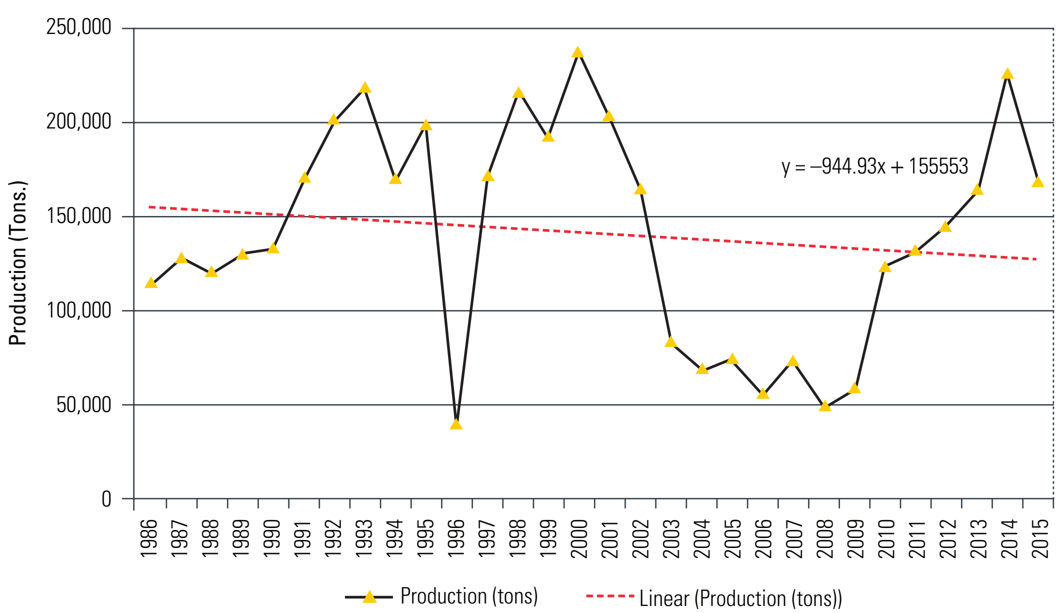


Figure C.13. Zimbabwe: Tobacco Yields (kg/ha), 1986–2015

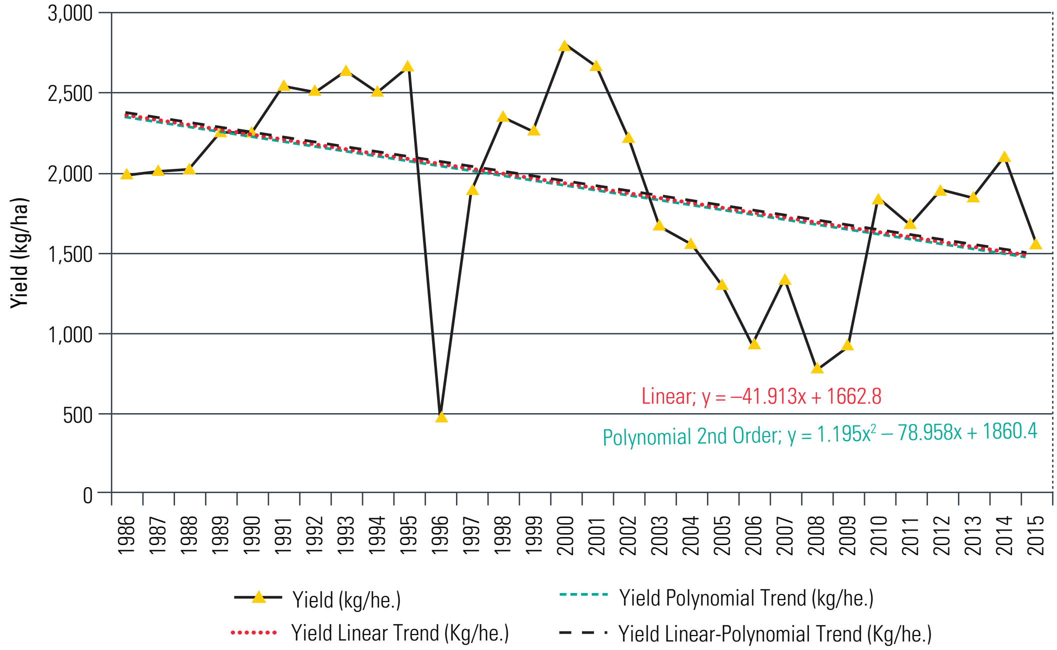
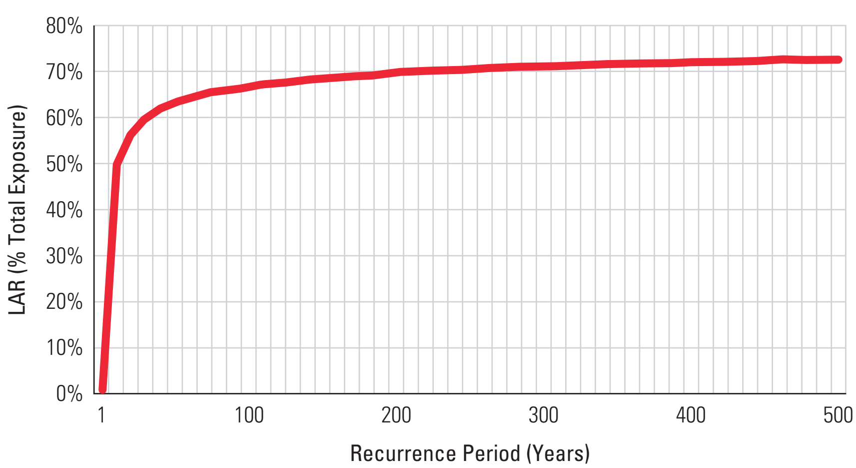


Table C.5. Zimbabwe: Expected LaR Values for Tobacco for Different Return Periods

Recurrence (years)	10	25	50	100	150	200	250	500
LaR (% exposure)	49.55%	58.43%	63.11%	66.72%	68.48%	69.62%	70.38%	72.61%
LaR (US$ millions)	177.8	209.7	226.5	239.4	245.7	249.8	252.6	260.5

Figure C.14. Expected LaR for Different Recurrence Periods for Tobacco in Zimbabwe



Sugarcane Crop Risk Assessment

Sugarcane is an important crop in Zimbabwe. It covers 44,273 hectares and is essential for distillation and ethanol production, providing sweeteners for industry, making molasses for cattle feed, earning foreign exchange, and generating electricity. Sugarcane GVP amounts to US$177 million, which makes this crop the third most important in the country from an economic standpoint. Sugarcane production takes place in northwestern Zimbabwe in the Lowveld, which has been identified as one of the best places in the world to produce sugar at competitive costs. The climate is ideal for sugarcane and the distances from the mill are quite manageable.

Sugarcane yields have shown a downward trend, falling from 110 tons per hectare in the 1980s to 77 tons per hectare in 2015, for three reasons. The first reason is farmers' limited access to inputs. Fertilization rates are far from optimal, and most farmers never plow out the cane due to lack of resources. The second reason is that farmers do not use appropriate crop management practices. The third reason is the lack of capital equipment for sugarcane production. Most farmers in Zimbabwe do not even have a tractor, which is essential machinery for land preparation and hauling cane. Figures C.15 and C.16 show the evolution of sugarcane production and yields over the period 1986–2015.

Sugarcane is produced under irrigation and hence is a low-risk crop. The average loss cost for sugarcane is 6.95 percent of GVP or US$12.3 million. The LaR for sugarcane indicates that this crop may face an aggregate loss equivalent to 24 percent of the national crop GVP (or US$42.5 million) once in 100 years or a loss of 25.13 percent of national crop GVP (US$44.5 million) once in 250 years. Table C.6 and Figure C.17 show the expected LaR values for sugarcane in Zimbabwe for different return periods.

Groundnut Crop Risk Assessment

Groundnuts are currently planted on 230,000 hectares in Zimbabwe. Groundnuts are grown by a large proportion of smallholder farmers (36 percent), but despite the crop's importance, production and productivity have remained low and stagnant at less than 500 kilograms per hectare, for three reasons. First, poor access to quality seed of improved varieties make farmers rely on retained seed of landraces. Second, farmers lack knowledge and skills in groundnut production. Third, farmers have poor market access. Figures C.18 and C.19 summarize the evolution of groundnut production and yields over 1986–2015.

The GVP of groundnuts is estimated at US$43.5 million. Groundnut exposures accounts for 4.5 percent of the crop exposures in the country.

The main peril affecting groundnuts in Zimbabwe is drought. Groundnut production shortfalls in relation to expected yields were particularly bad during the

Figure C.15. Zimbabwe: Sugarcane Production (t), 1986–2015

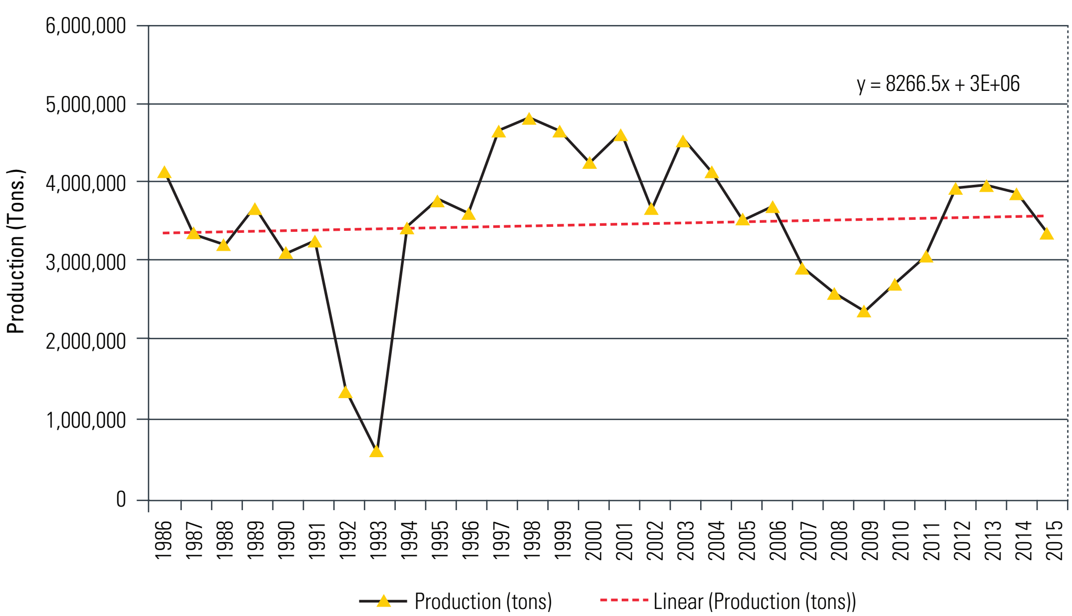


Figure C.16. Zimbabwe: Sugarcane Yields (kg/ha), 1986–2015

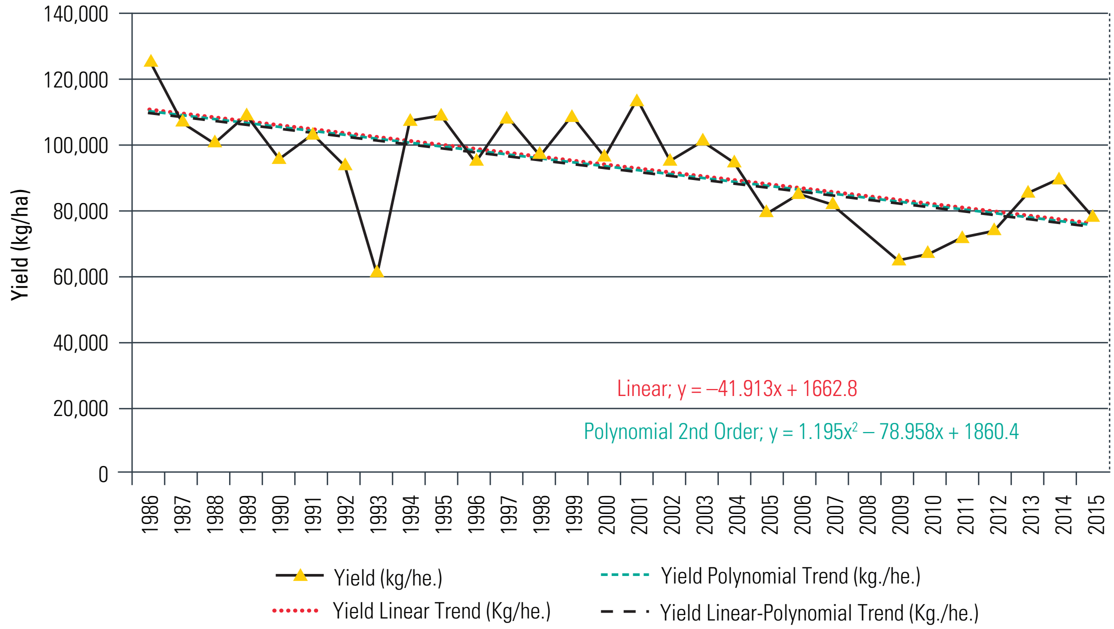


Table C.6. Zimbabwe: Expected LaR Values for Sugarcane for Different Return Periods

Recurrence (years)	10	25	50	100	150	200	250	500
LaR (% exposure)	18.48%	21.41%	22.90%	24.02%	24.55%	24.87%	25.13%	25.77%
LaR (US$ millions)	32.7	37.9	40.6	42.5	43.5	44.1	44.5	45.6

Figure C.17. Zimbabwe: Expected LaR for Sugarcane for Different Recurrence Periods

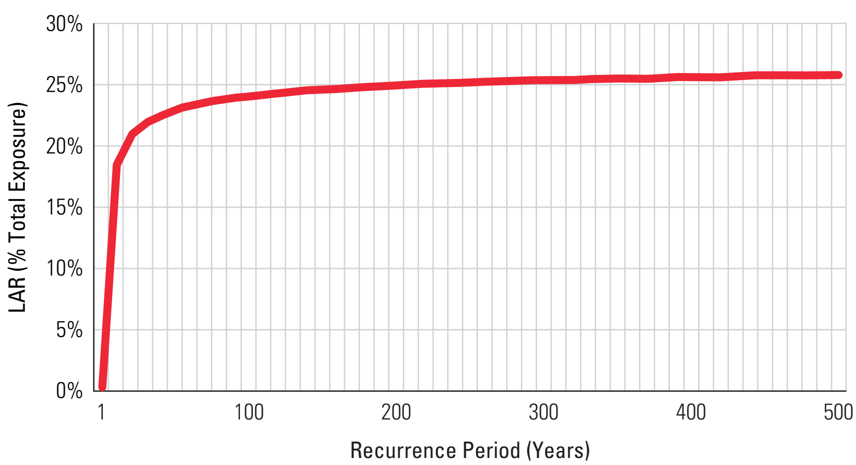
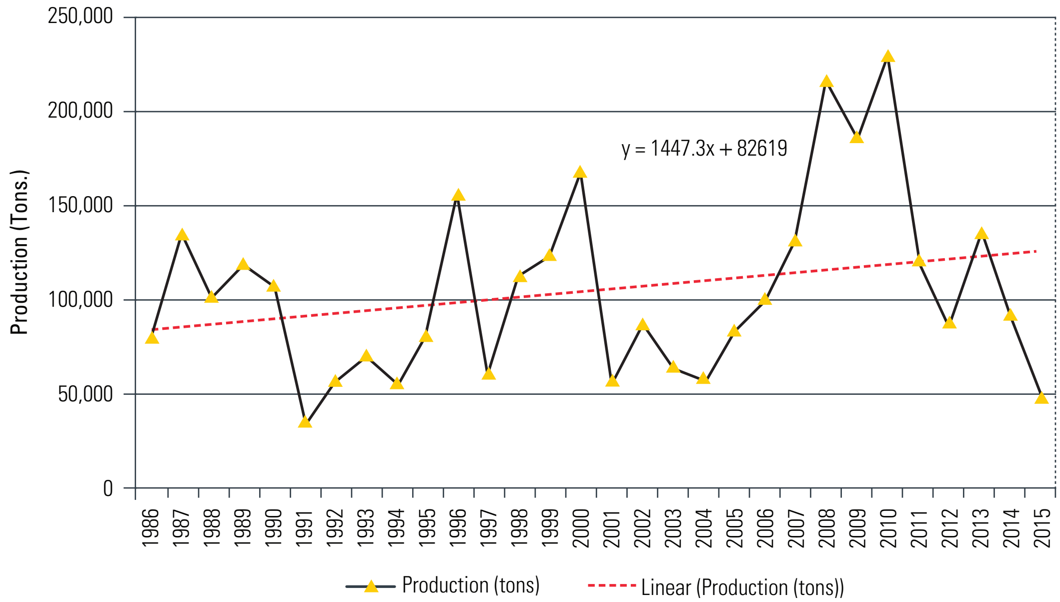


Figure C.18. Zimbabwe: Groundnut Production (t), 1986–2015



1991, 2001, and 2015 droughts (60 percent, 55 percent, and 35 percent, respectively). The expected average loss for groundnuts in the country accounts for 8.9 percent of its GVP (US$3.9 million). The expected LaR for this crop is 43.6 percent of the GVP (US$18.9 million) for a recurrence period of 100 years and 48.3 percent of GVP (US$21 million) for a recurrence period of 250 years. Table C.7 and Figure C.20 present the expected LaR values for groundnuts for different return periods.

Cotton Crop Risk Assessment

Cotton was once a strategic crop for poverty alleviation in Zimbabwe. Cotton contributed sustainably to rural income, rural development, employment, and export earnings. The sector was a major source of livelihood for over one million people, including farmers, farm workers and the textile industry, as it once contributed about 19 percent of the

Figure C.19. Zimbabwe: Groundnut Yields (kg/ha), 1986–2015

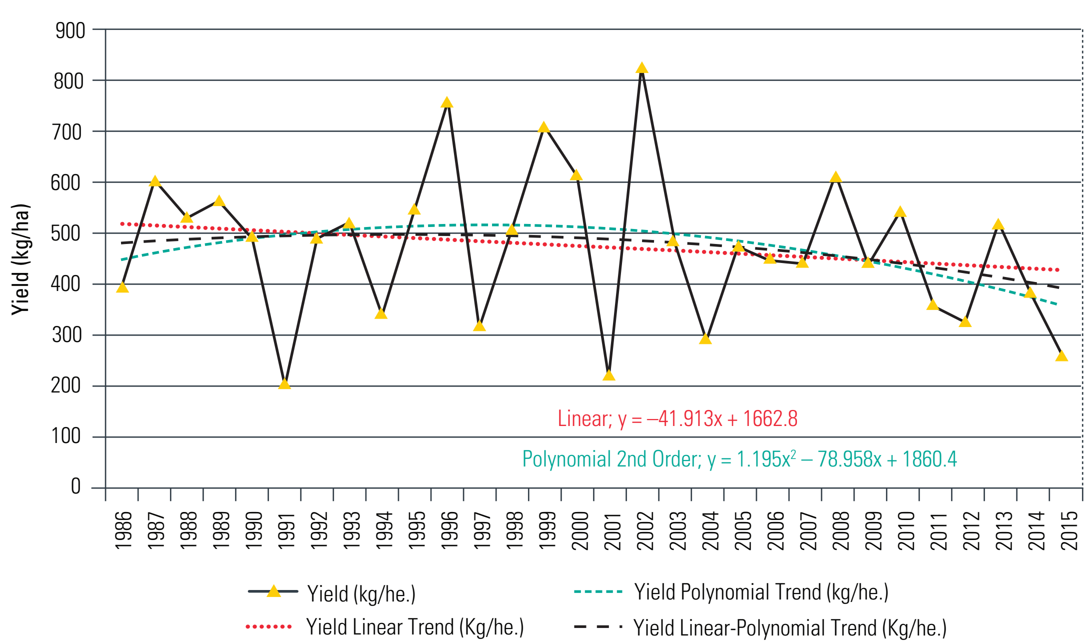


Table C.7. Zimbabwe: Expected LaR Values for Groundnuts for Different Return Periods

Recurrence (years)	10	25	50	100	150	200	250	500
LaR (% exposure)	26.72%	34.61%	39.42%	43.60%	45.81%	47.23%	48.31%	51.57%
LaR (US$ millions)	11.6	15.1	17.2	19.0	19.9	20.6	21.0	22.5

country's agricultural export earnings. It was the mainstay of rural communities, resulting in the development of areas like Gokwe, Sanyati, Rushinga, Checheche, Muzarabani, Matepatepa in Bindura, and Muzarabani.

The number of farmers cultivating this crop has recently suffered a sharp decline. In 2012, cotton was cultivated by about 200,000 smallholders, while in 2014 an estimated 170,000 small-scale cotton producers grew the crop, representing an average 15 percent decline in two years. The cotton subsector started to experience serious trouble because many farmers failed to access adequate inputs from contractors, and some contractors (such as Cottco and Cargill) ceased operations. The loss of cotton profits has destroyed livelihoods in rural areas where peoples' existence was intricately linked to growing the crop. Distortions in the producer price have also had a negative effect on production, as farmers have abandoned cotton production in favor of crops such as tobacco, maize, and soybeans. Currently the area planted with cotton is 150,000 hectares, and the GVP for this crop is estimated at US$37.5 million. Figures C.21 and C.22 show the evolution of cotton production and yields over 1986–2015.

The main peril affecting cotton in Zimbabwe is drought, which was especially serious in 1991, 2001, and 2015, when production shortfalls in relation to expected yields were 65 percent, 36 percent, and 37 percent, respectively. The expected average loss for this crop accounts for 9.8 percent of its GVP. The expected LaR for this crop is 50.7 percent of the GVP for a recurrence period of 100 years and 56.2 percent of GVP for a recurrence period of 250 years. Table C.8 and Figure C.23 present the expected LaR values for cotton for different return periods.

Coffee Risk Assessment

Zimbabwe's coffee belt has perfect conditions for growing the beans: high mountain peaks and cool climates. The country was once famous for the "super-high quality" and flavor of its beans. In the 1990s it produced some of the best coffee in the world, alongside South America and Kenya, generating crucial foreign currency and a livelihood for many laborers and small-scale farmers, as well as the big commercial farms.

Today the industry is in decline: many mills are abandoned, and farmers are in debt. The country produced 500 tons of coffee in 2017 compared to 15,000 tons in 1989. The number of commercial producers has fallen from 120 before the land reform

Figure C.20. Zimbabwe: Expected LaR for Groundnuts for Different Recurrence Periods

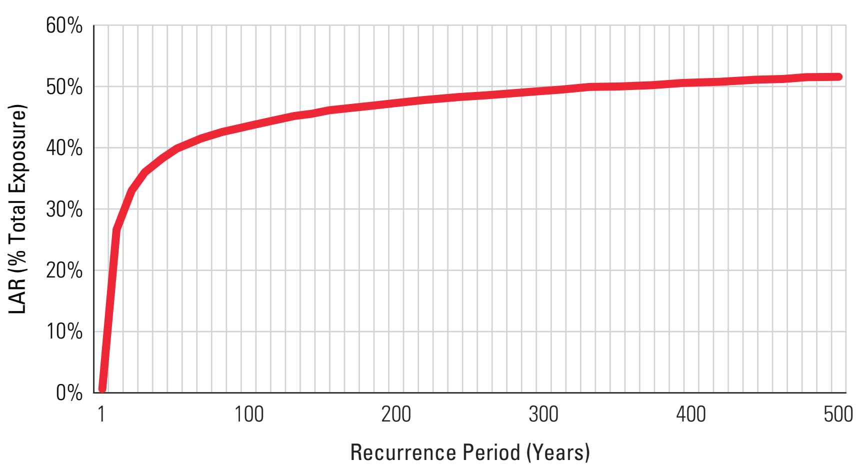


Figure C.21. Zimbabwe: Cotton Production (t), 1986–2015

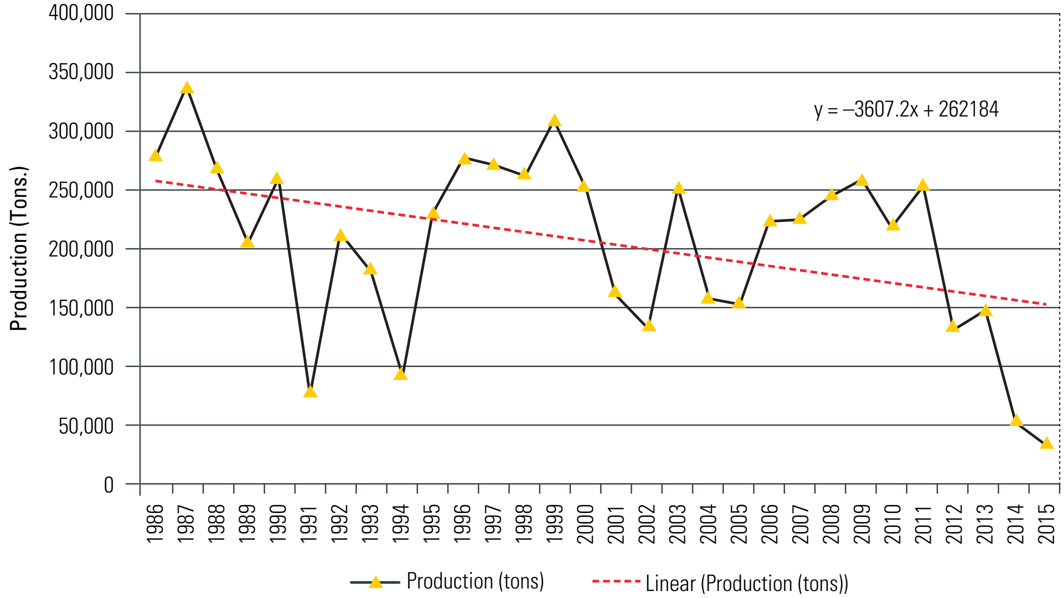


Figure C.22. Zimbabwe: Cotton Yields, 1986–2015

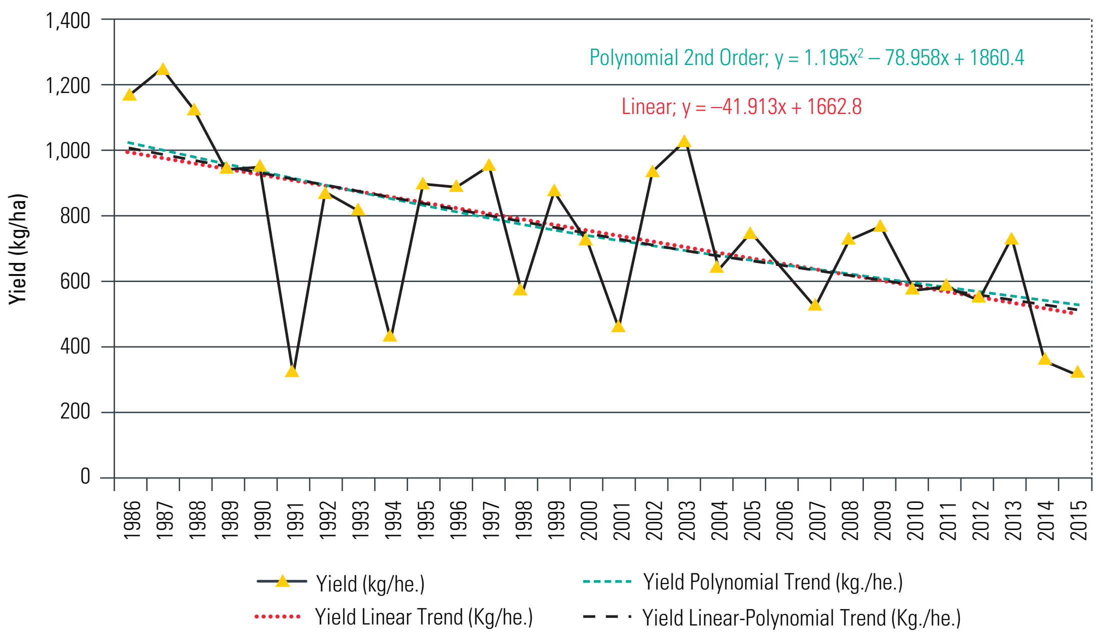
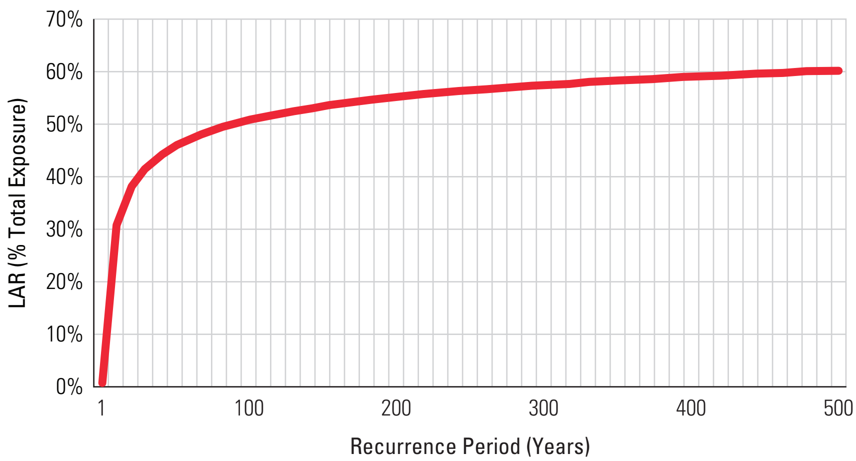


Table C.8. Zimbabwe: Expected LaR Values for Cotton for Different Return Periods

Recurrence (years)	10	25	50	100	150	200	250	500
LaR (% exposure)	30.60%	40.05%	45.77%	50.71%	53.27%	55.02%	56.27%	60.05%
LaR (US$ millions)	11.5	15.0	17.2	19.0	20.0	20.7	21.1	22.6

Figure C.23. Zimbabwe: Expected LaR for Cotton for Different Recurrence Periods



program to just 3 today. Coffee plantations in Zimbabwe occupy only 2,225 hectares. Figures C.24 and C.25 show the evolution of coffee production and yields over 1986–2015.

Coffee production is a high-risk endeavor in Zimbabwe. The expected average loss for this crop accounts for 20.37 percent of its GVP, while the expected LaR for a recurrence period of one in 100 years is 37.7 percent.

Sorghum Crop Risk Assessment

Sorghum is an important crop in the driest regions of the county. Being drought tolerant, it has a strong adaptive advantage and lower risk of failure than other cereals in such environments. The current area planted with sorghum in Zimbabwe is 250,000 hectares. Like other crops in Zimbabwe, sorghum shows a downward yield trend. The GVP for this crop in

Figure C.24. Zimbabwe: Coffee Production (t), 1986–2015

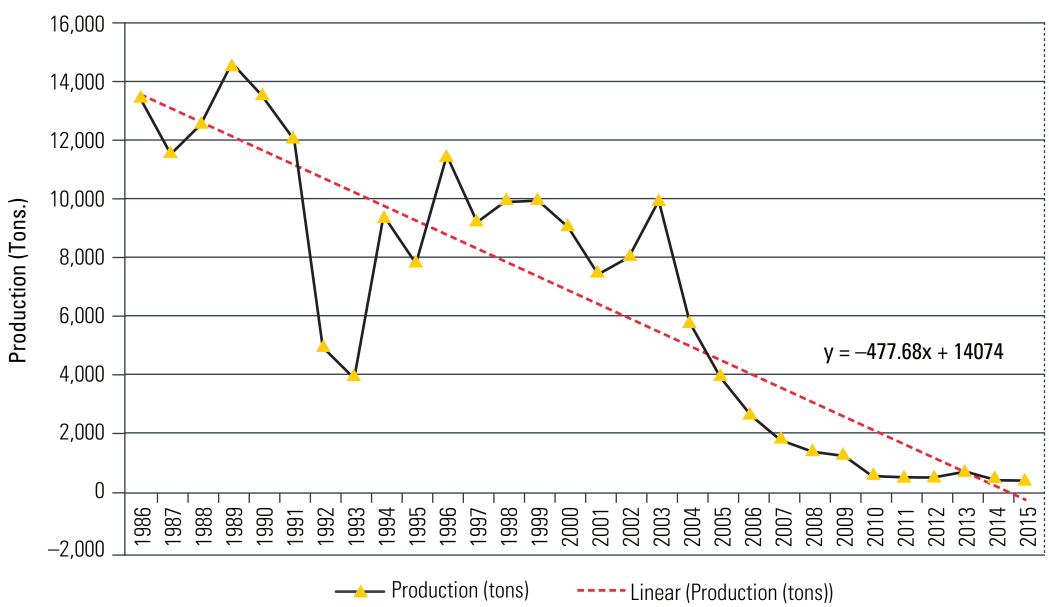
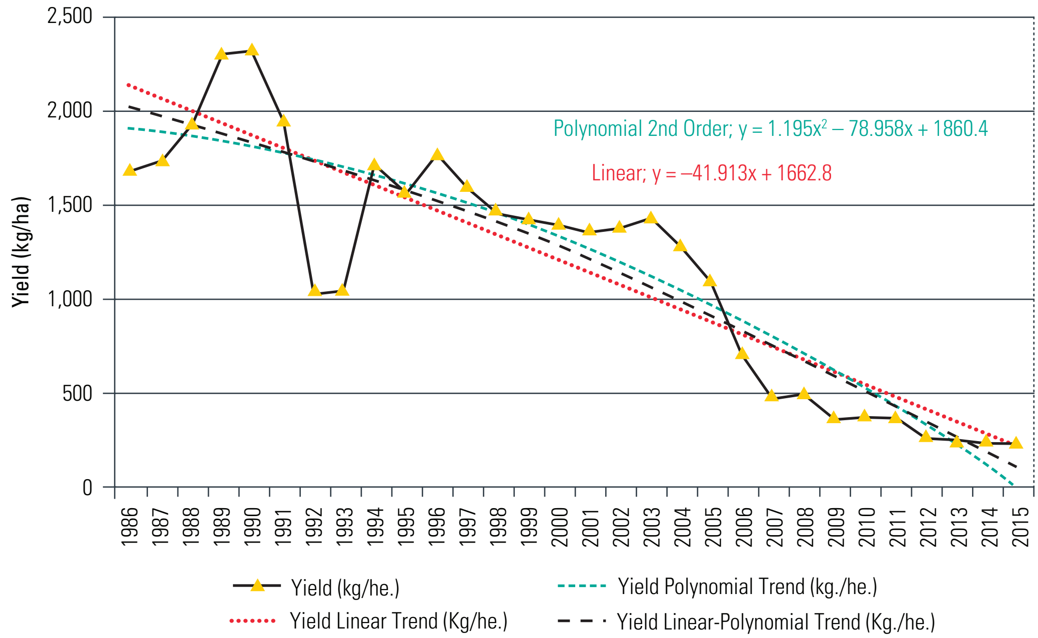


Figure C.25. Zimbabwe: Coffee Yields (kg/ha), 1986–2015



Zimbabwe amounts to US$19.2 million. Figures C.26 and C.27 show the evolution of sorghum production and yields over 1986–2015.

The expected average loss for this crop accounts for 13.5 percent of its GVP, while the expected LaR for this crop is 51 percent of the GVP for a recurrence period of 100 years, and 54.4 percent of the GVP for 250 years. Table C.9 shows the expected LaR values for sorghum for different return periods.

Wheat Crop Risk Assessment

Wheat production in Zimbabwe is small and way below the level of consumption. Wheat production has been declining since 2001, when Zimbabwe produced more than 300,000 tons. Several constraints, such as unreliable power supplies for irrigating the crop, dilapidated irrigation infrastructure, and late payments by the GMB have contributed to declining

Figure C.26. Zimbabwe: Sorghum Production (t), 1986–2015

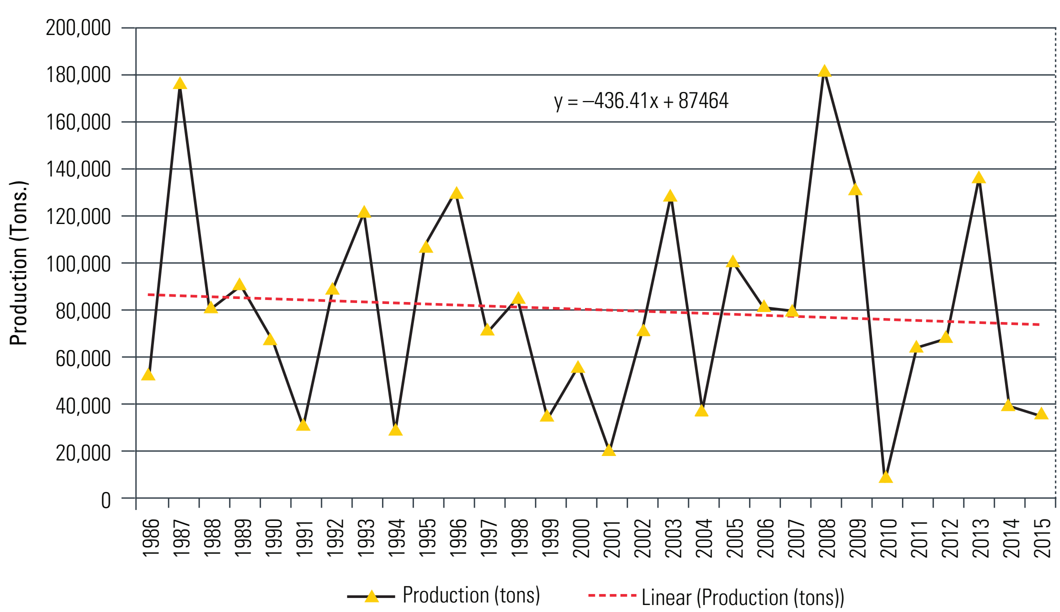
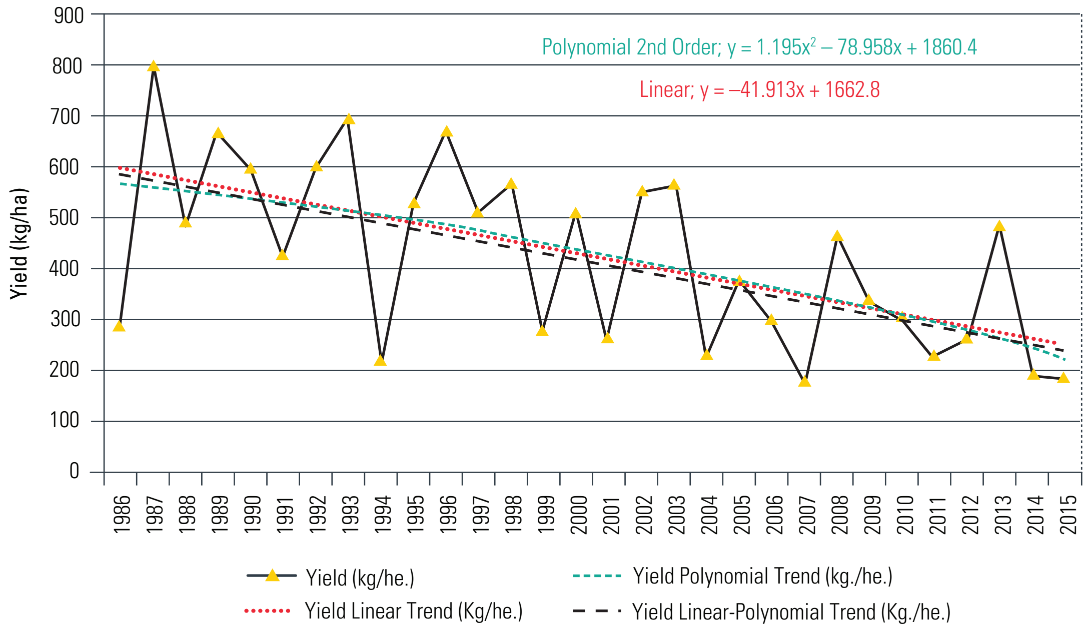


Figure C.27. Zimbabwe: Sorghum Yields (kg/ha), 1986–2015



wheat production. Currently wheat is produced on only 14,500 hectares, and production is approximately 47,000 tons per year. Wheat GVP amounts to US$24.1 million. Figures C.28 and C.29 show the evolution of wheat production and yields over 1986–2015.

Wheat production was severely affected by the droughts of 1991, 2001 and 2007, falling by 61 percent in relation to the expected yield in 1991, 88 percent in 2001, and 69 percent in 2007. The expected average loss for this crop accounts for 14.77 percent of its GVP, while the expected LaR for a recurrence period of one in 100 years is 84 percent of the GVP, and the LaR for a 250-year return period is 95 percent of the GVP. Table C.10 shows the expected LaR values for wheat for different return periods.

Soybean Crop Risk Assessment

Soybeans are one of Zimbabwe's high-value crops, and soybean production has strong industry linkages because it the crop be processed into such value-added products as soybean cake, soymilk, and soybean oil (30 percent of the cooking oil in the country is made from soybeans). Soybean cake, a byproduct of oil extraction, is sold to feed manufacturers. Soybeans were originally produced by large-scale farmers. Since the land reform in 2000, the share of production from small-scale farms has increased. National output has dropped in recent years to about 50,000 tons per year, produced on 48,000 hectares. This reduction is attributed to a shrinking producer base and loss of productivity on small- and large-scale farms. Low output has caused considerable shortages of raw materials for cooking oil and feed. Currently large-scale commercial farmers account for 65 percent of national soybean production, and smallholders account for 35 percent. Soybean GVP amounts to US$3 million. Figures C.30 and C.31 show the evolution of soybean production and yields over 1986–2015.

Droughts in 1991 and 1994 caused soybean yields to drop by 35 percent each time. The expected average loss for this crop accounts for 19.8 percent of its GVP, while the expected LaR for a recurrence period of one in 100 years is 61 percent of GVP, and the LaR for a 250-year return period is 63 percent of GVP. Table C.11 shows the expected LaR values for cotton for different return periods.

Table C.9. Zimbabwe: Expected LaR Values for Sorghum for Different Return Periods

Recurrence (years)	10	25	50	100	150	200	250	500
LaR (% exposure)	36.89%	44.09%	48.02%	51.13%	52.70%	53.66%	54.40%	56.36%
LaR (US$ millions)	7.1	8.5	9.2	9.8	10.1	10.3	10.5	10.8

Figure C.28. Zimbabwe: Wheat Production (t), 1986–2015

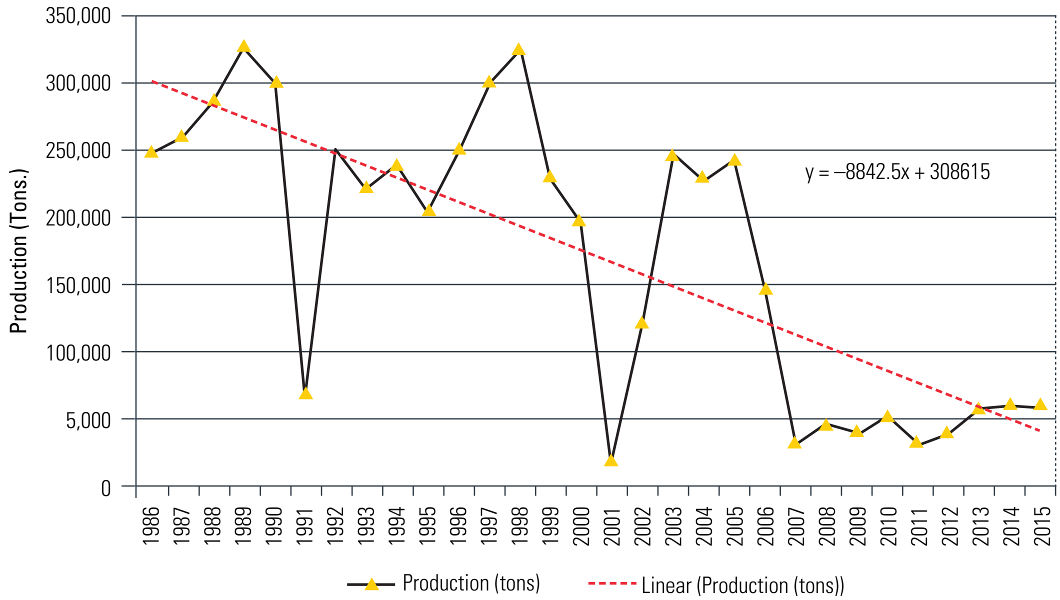


Figure C.29. Zimbabwe: Wheat Yields (kg/ha), 1986–2015

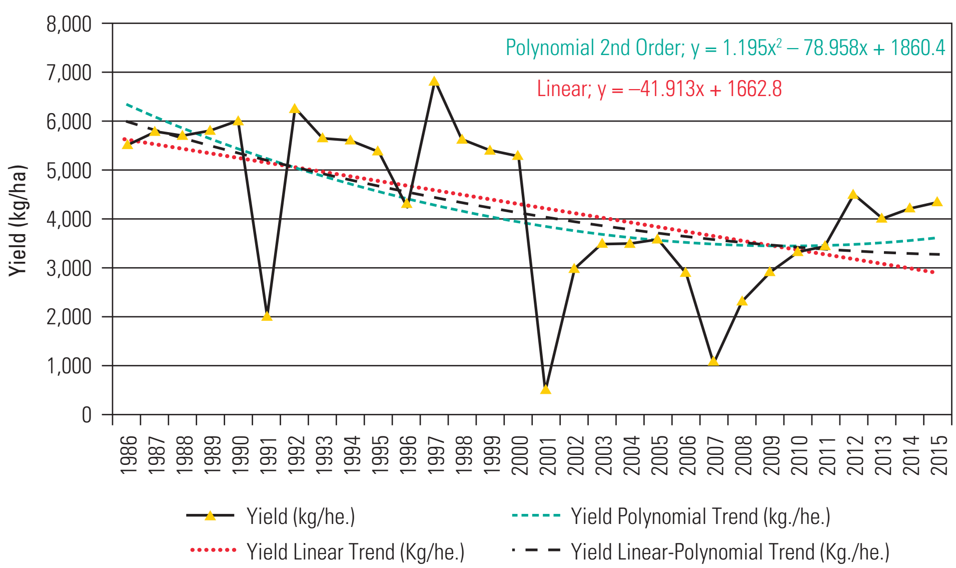


Table C.10. Zimbabwe: Expected LaR Values for Wheat for Different Return Periods

Recurrence (years)	10	25	50	100	150	200	250	500
LaR (% exposure)	47.46%	64.19%	74.79%	84.16%	89.32%	92.64%	95.35%	100.000%
LaR (USS millions)	11.4	15.5	18.0	20.3	21.5	22.3	23.0	24.1

Figure C.30. Zimbabwe: Soybean Production (t), 1986–2015

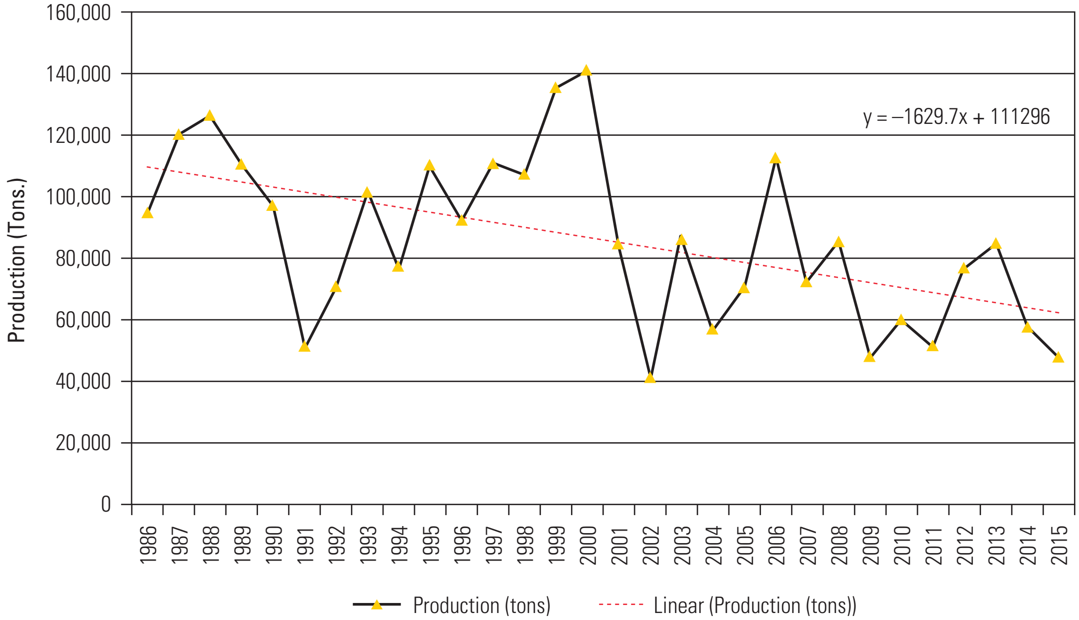


Figure C.31. Zimbabwe: Soybean Yields (kg/ha), 1986–2015

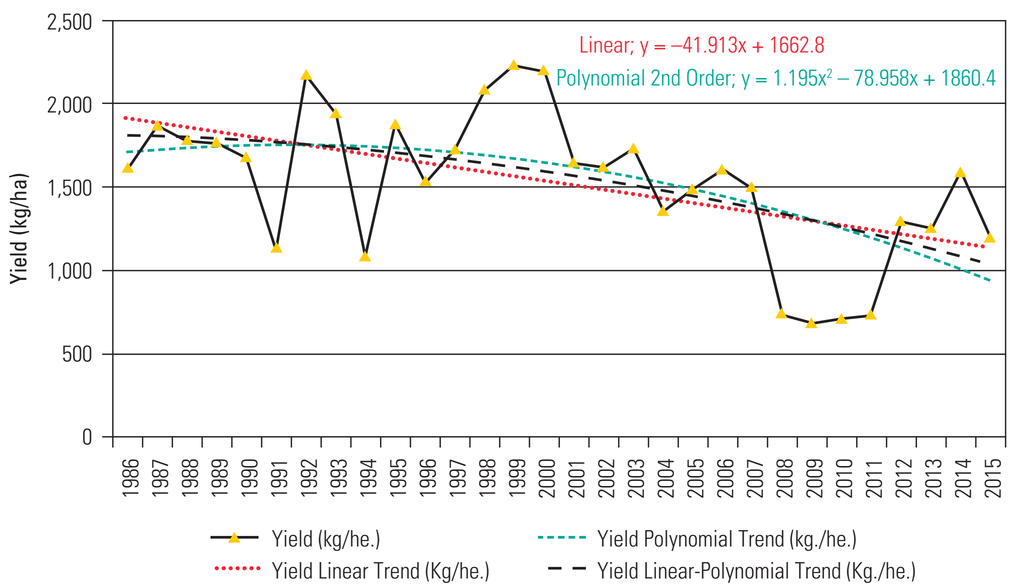


Table C.11. Zimbabwe: Expected LaR Values for Soybeans for Different Return Periods

Recurrence (years)	10	25	50	100	150	200	250	500
LaR (% exposure)	49.30%	55.60%	58.66%	60.90%	61.94%	62.58%	63.01%	64.22%
LaR (US$ millions)	11.3	12.7	13.4	13.9	14.2	14.3	14.4	14.7

APPENDIX D

RISKS FOR CROP AND LIVESTOCK SUPPLY CHAINS

Crops

Weather-Related Risks

The major historical risk in the agricultural sector of Zimbabwe is drought, usually accompanied by high temperatures. Substantial drops in maize production were caused by droughts in 1991/92, 1994/95, 2001/02, 2004/05, 2007/08, 2012/13, and 2015/16. Groundnut production was affected by the droughts of 1982/83, 1991/92, 1997/98 (Manicaland), 2001/02, 2004/05, 2007/08, 2012/13, and 2015/16. As both crops are considered food staples, those droughts reportedly affected food security in those years. For building the risk profiles of crops, a quantitative assessment of losses was made by estimating the variation in yields away from the historical trend line and multiplying the output losses by the average price of the last three years (for more details on the methodology, see Appendix B). Secondary data and interviews with stakeholders completed the sources of information. Figures D.1 and D.2 show the reconstructed timeline of events and the annual estimated losses in maize and groundnuts.

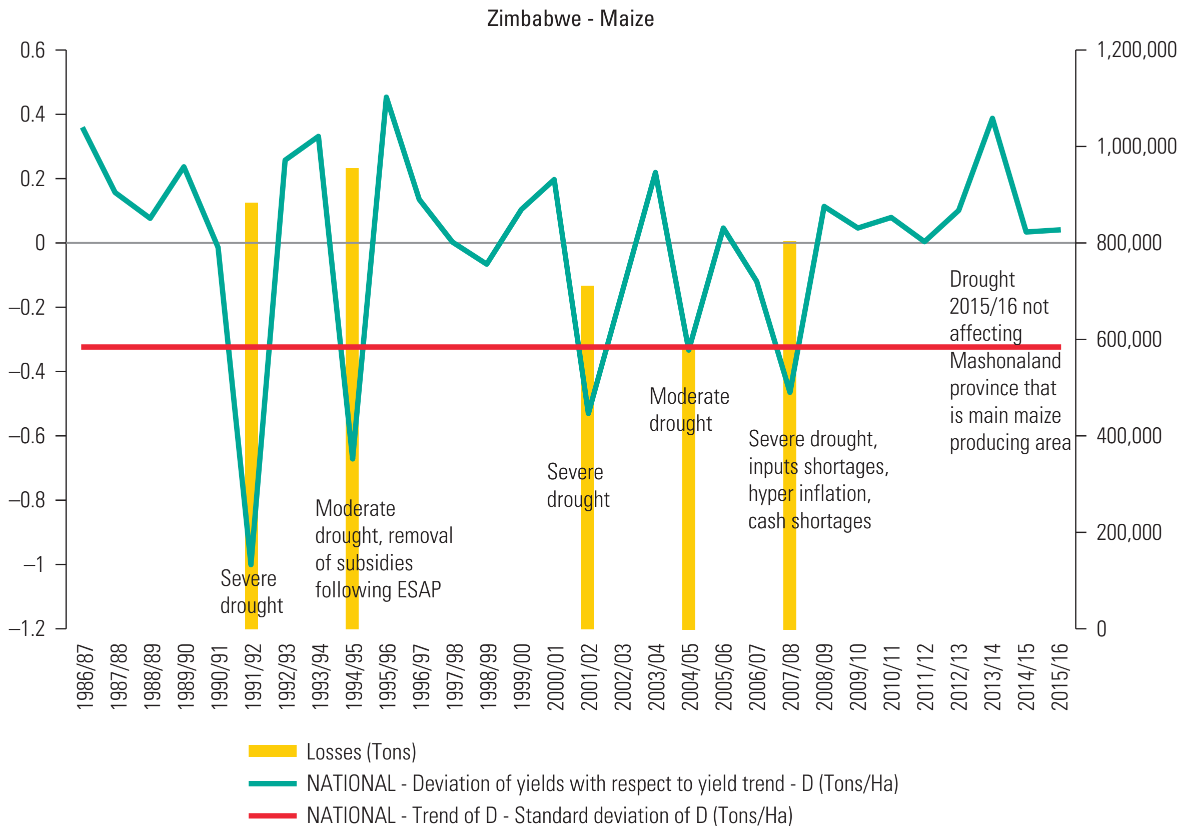
For maize, there were 5 years in which drought caused yields to deviate more than one standard deviation from the trend line; for groundnuts, a similar deviation is observed for 6 years within the 30-year period. In Chapter 4, these deviations are monetized to estimate the value of losses, permit comparisons among crops, and prioritize risk.

The vast majority of smallholders cultivate land under rainfed conditions and have limited means of protecting themselves from the effects of drought and/or prolonged dry spells, so they ultimately absorb the effects of droughts in their productive systems, incomes, and/or consumption. The impact of drought and other risk events is not only perceived by farmers in terms of production losses but by consumers as higher retail prices when market shortages of basic food staples occur. For example, maize retail prices increased in 2008/09, 2014/15, and 2016/17 following droughts, and in 2008 as a result of the shortage of cash and other enabling environment problems (Figure D.3).

The southern part of the country (corresponding to the dry agro-ecological Regions IV and V) is particularly exposed to drought risk. Drought in those regions occurs on average every 3-5 years. For example, Masvingo experienced severe drought in 2009/10 while no drought occurred in Mashonaland provinces during that period. Severe droughts are not that frequent in other regions, occurring every 8-10 years and inducing temporary shortages and price hikes (for instance, in horticultural produce). An effective strategy based on the prevention and mitigation of drought risk with conservation technologies and livelihood diversification (among others) was discussed with various stakeholders as a priority to face severe droughts in a sustainable manner in the most exposed agro-ecological zones (IV and V).

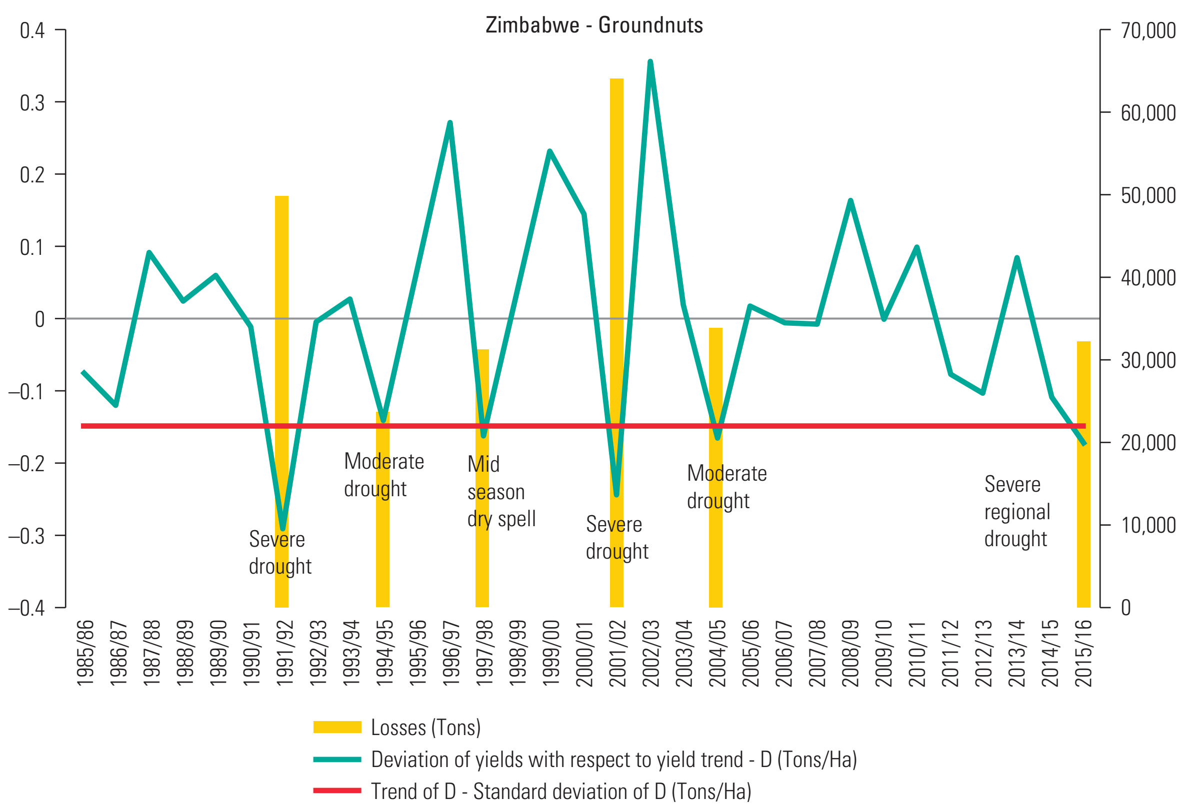
Weather risks have different impacts in Zimbabwe's different agro-ecological environments (regions). For example, maize is produced in each of the 10 provinces of Zimbabwe, and the regional differences in terms of weather and soils determine the potential to grow maize, as well as the impact of weather-related risks. The major maize-producing provinces are the Mashonaland provinces in the North, where weather variability is less extreme, whereas the dry southern provinces (Masvingo, Matebeleland South, and

Figure D.1. Maize: Estimated Annual Yield Losses



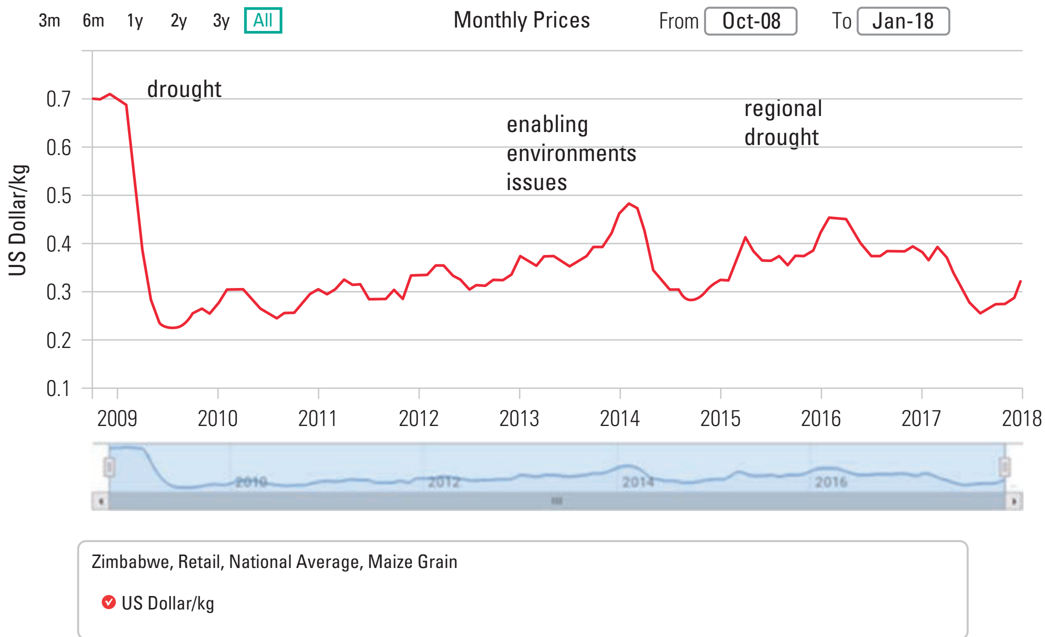
Source: Ministry of Land Agriculture Rural Resettlement of Zimbabwe.

Figure D.2. Groundnuts: Estimated Annual Yield Losses



Source: Ministry of Land Agriculture Rural Resettlement of Zimbabwe.

Figure D.3. National Retail Maize Prices in Zimbabwe



Source: FAO/GIEWS.

Matebeleland North)—agro-ecological Regions IV and V—are typically less productive. Dry spells are more frequent in the southern regions and sometimes become consecutive and prolonged. And in effect, maize production in Masvingo and Matebeleland has the highest yield coefficient of variation (Table D.1).[1]

Like groundnuts, cotton, despite being another drought-tolerant crop, was also adversely affected by the severe droughts of 1991/92, 2001/02, and 2007/08 (Figure D.4). Moderate droughts experienced in 1994/95 and 2015/16 also negatively affected cotton production, but to a lesser extent. All cotton is generally produced under rainfed conditions, mostly in Midland and Mashonaland Central Provinces.

Table D.1. Variation in Maize Yields by Province, Zimbabwe

Province	Yield coefficient of variation(%)
Mashonaland West	37.0
Mashonaland Central	33.3
Mashonaland East	34.1
Manicaland	34.5
Midlands	52.9
Masvingo	58.8
Matebeleland North	55.5
Matebeleland South	64.2

Source: Ministry of Land Agriculture Rural Resettlement of Zimbabwe

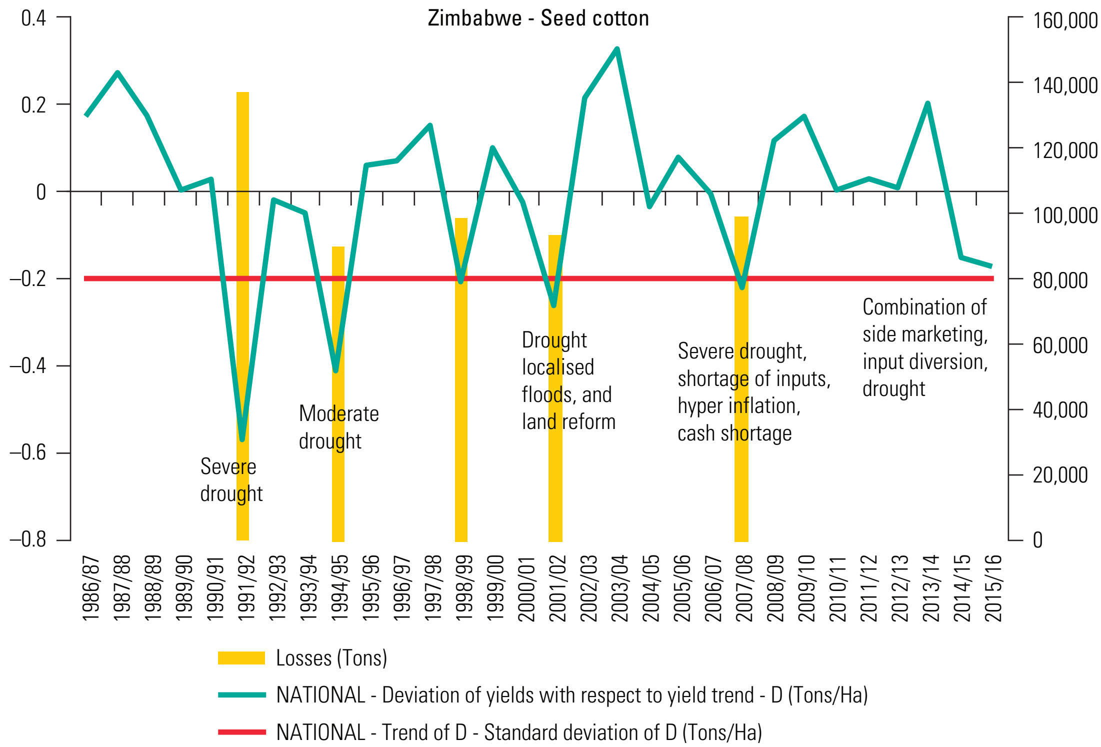
Drought also has potential to be a significant hazard to wheat production when it is severe and widespread, as in 1992 and 2008 (Figure D.5). Drought remains a serious hazard for wheat despite the fact that the crop is grown during the winter under irrigation, mostly by medium- to large-scale commercial farmers.

Severe droughts affect water availability for irrigation, as water reservoirs will be filled to low capacity. The effect is more crippling to smallholder and commercial wheat farmers who do not have secure financial resources and lack access to high-capacity reservoirs and extensive irrigation infrastructure.

Horticulture, like wheat production, is carried out under intensive irrigation. It suffers heavily from severe drought as in 1992, when reservoirs had water deficits, rivers dried up, and soils experienced moisture stress. Farmers usually try to manage the drought risk by reducing the area planted to horticultural crops, replacing them with more drought-tolerant crops, and focusing on irrigation of high-value horticultural crops destined for export.

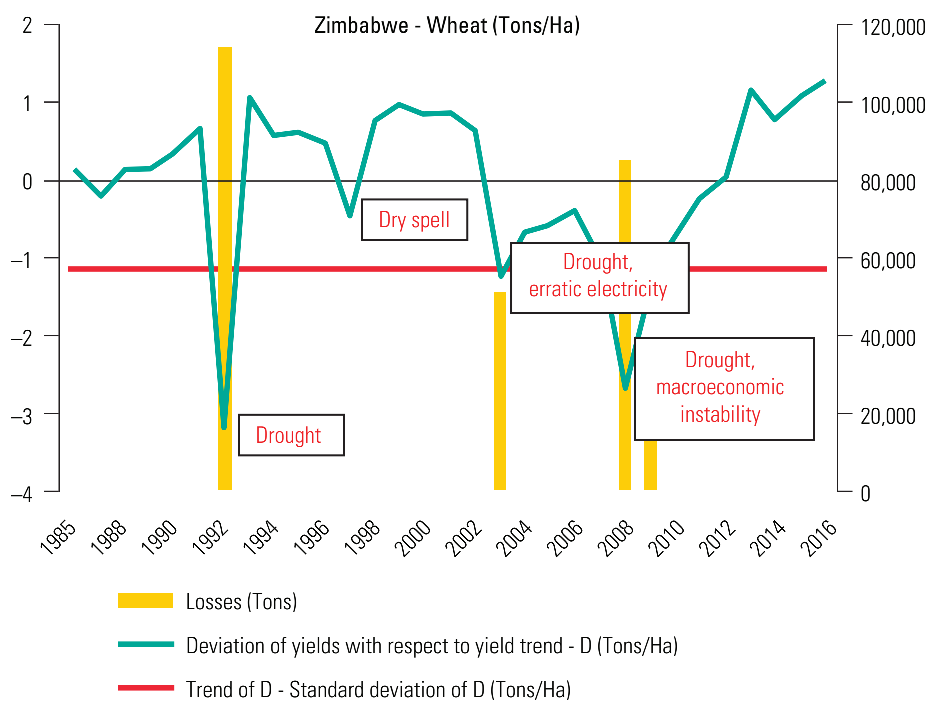
Frost affects almost all horticultural produce, including fruits and vegetables. It occurs frequently in Zimbabwe, particularly in Regions I and II, where temperatures are cooler and drop dramatically between late April and August. Frost differs in intensity and is more severe during the cold winter years.

Figure D.4. Seed Cotton: Estimated Annual Yield Losses



Source: Ministry of Land Agriculture Rural Resettlement of Zimbabwe

Figure D.5. Wheat: Estimated Annual Losses



Source: Ministry of Land Agriculture Rural Resettlement of Zimbabwe

Frost disrupts the growth and flowering stages of plants; tissues blacken and become necrotic, triggering early senescence in the crop. Fruits and vegetables that would have matured for harvest develop blisters and have decaying, water-soaked tissues. To combat the effects of frost, producers plant early before the onset of frost, increase sprinkler irrigation, and practice mulching to trap heat.

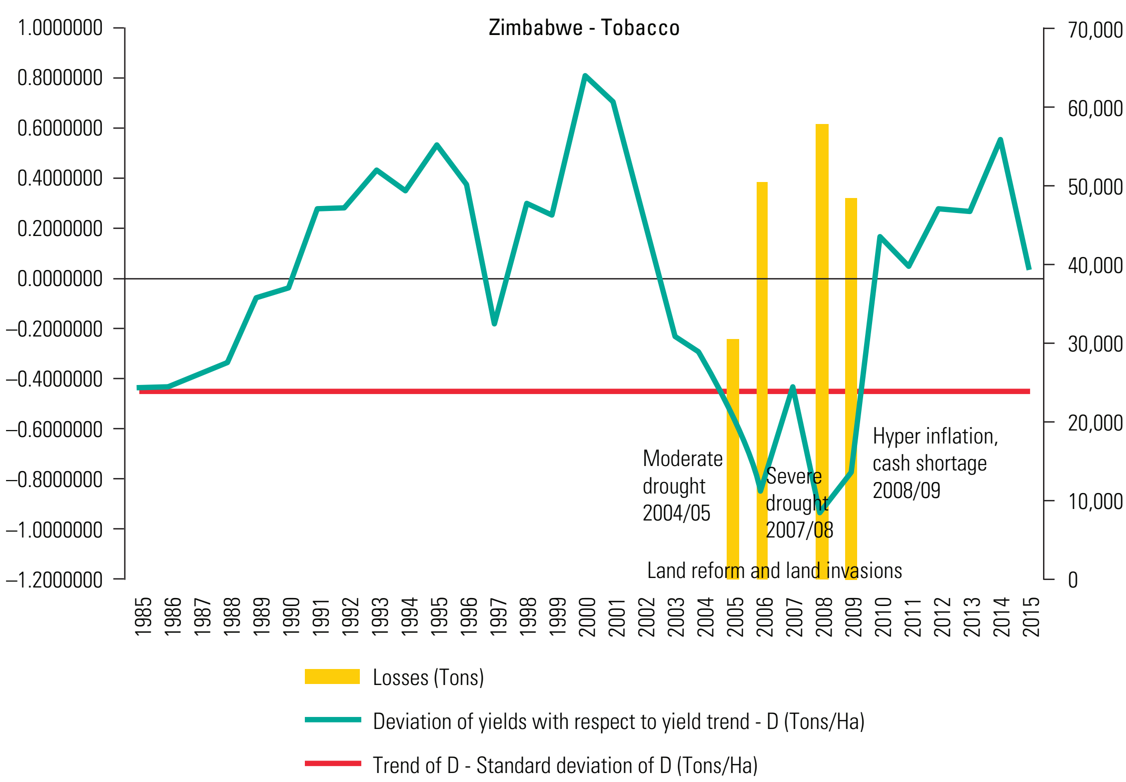
Hailstorms are also common in Regions I and II, where most of the horticulture occurs during the rainy season. Hailstorms damage plant leaves and stems, reducing the photosynthetic capacity of the crop and thus resulting in delayed maturity of the produce and reduced yields. Fruits and vegetables suffer from mechanical damage, which leaves them exposed to invasion by pathogens and pests in the field and after harvest. The mechanical damage reduces the quality of the crop, resulting in reduced market prices for the produce. During the onset of the rainy season, hailstorms can also affect tobacco by destroying the leaves (which are the final product for tobacco farmers). Hailstorms are an idiosyncratic risk, however, not a widespread one. The typical way to manage the impacts of a hailstorm is to buy insurance. Producers have very low capacity to cope with hailstorms and usually resort to replanting, especially if the hailstorms occur early in to the rainy season when the crops are immature.

Climate variability in Zimbabwe also manifests as an early onset of the rainy season. An early onset of rainfall that coincides with wheat planting and germination has a detrimental effect on the development of the crop and its eventual quality. Farmers counteract this risk by planting as early as acceptable. Additionally, excess rains that fall when wheat has reached maturity can significantly reduce yield and quality.

Prolonged dry spells and erratic rainfall are frequent in every province at least once in every three years. Mid-season dry spells mainly occur in January and February, when maize and groundnuts are flowering, and affect yields of those crops. Prolonged mid-season dry spells also threaten the availability of water to sustain the irrigation that supports horticulture. Producers practice conservation methods and mulching that minimally disturbs the soil to maintain soil moisture and fertility so that crops do not suffer from water stress and are able to cope through the duration of the dry spell.

Dry spells have no significant effect on tobacco yields but negatively affect quality. Figure D.6 shows

Figure D.6. Tobacco: Estimated Annual Yield Losses



Source: Ministry of Land Agriculture Rural Resettlement of Zimbabwe historic drought events and their impact on tobacco yields. The dry spells normally occur when the tobacco crop is already established.

Early cessation of rains before the end of the growing season is also reported, affecting all crops.

Marked negative changes in sugarcane production associated with droughts were noted in 1973/74, 1992/93, and 2008/09 (Figure D.7). The 1973/74 drought, which occurred between two above-normal seasons (1972/73 and 1974/75) resulted only in moderate losses in yield and output, as water reserves from other seasons could be used to irrigate the crop. The 1991/92 severe drought that succeeded three consecutive years of moderate drought curtailed the water supply for irrigation and caused high losses in sugarcane yield and output. In 2008/09, drought and other macro-economic hardships jointly contributed to a marked decline in performance in the sugarcane sector.

Flooding is another risk, but it mainly affects maize yields in a few areas of the country, particularly Muzarabani in Mashonaland Central and some parts of Masvingo and Midlands. Farmers practicing stream bank cultivation to mitigate drought are more exposed to floods. Cotton is grown in low-lying areas prone to floods owing to their flat terrain and low altitude, but cotton can withstand the effects of moderate flooding, because it is generally a deep-rooted, strongly established crop.

All of these risks directly affect farmers but also affect processors and traders when the raw materials for their operations become scarce and most likely more costly.

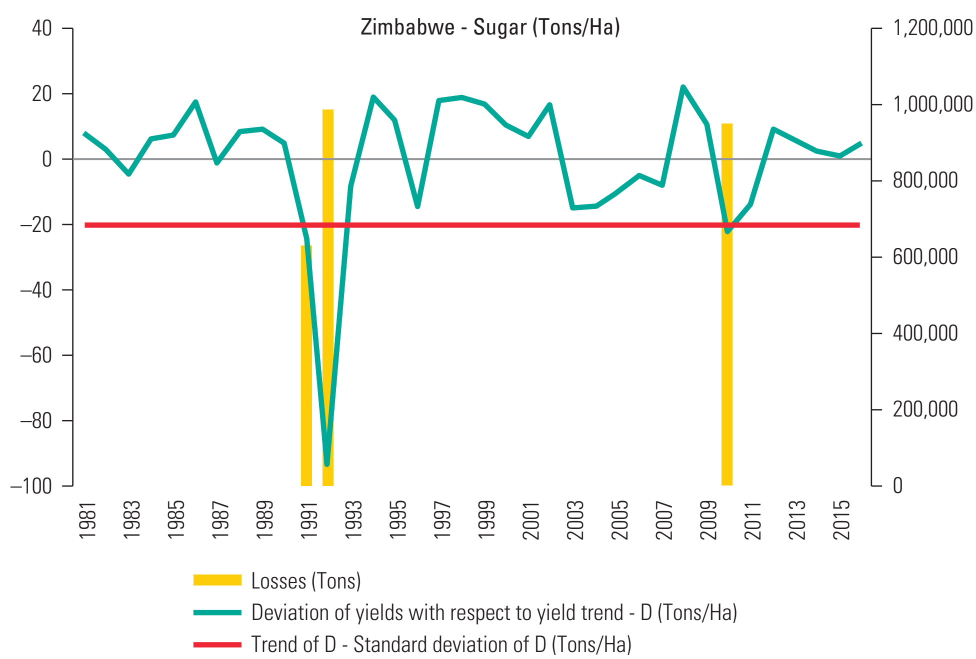
Phytosanitary Risks

Pests and diseases in all crops are not a major risk if controlled with agrochemicals, although the cost of these chemicals is high, and most smallholder producers cannot afford them. In horticulture, the incidence of pests and diseases is exacerbated by excess rain, as excess moisture provided appropriate conditions for pathogens to breed and for pathogens and pests to disperse from one plant to another.

Fungicide resistance is acknowledged to be growing in wheat and horticulture. Adoption of genetically resistant varieties and rotations of agrochemicals are promoted to combat fungal diseases. Some large-scale horticultural farms implement integrated pest management systems, which use a combination of biological, cultural, and chemical means to eliminate pests.

In addition to pests and diseases, crops can be susceptible to plagues such as quelea birds (*Quelea quelea*) in wheat. These birds are a problem every season, and farmers tend to team up to physically ward them off from their fields.

Figure D.7. Sugarcane: Estimated Annual Yield Losses



Source: Zimbabwe Sugar Association (ZSA).

Various new pest outbreaks have been reported. One relatively new pest, fall armyworm (*Spodoptera frugiperda*), invaded Zimbabwe in 2016 and poses an immediate risk to wheat and maize production. The fall armyworm is known to cause extensive damage. In the field it is often identified late, as it is difficult to differentiate from other caterpillars and burrows into the stem, where it is shielded from pesticides. The current capacity to manage fall armyworm is inadequate. This pest is not fully researched in Zimbabwe, and the extension services have little knowledge of its management. Another important pest, the maize grain borer, destroys maize after harvesting. In cotton, emerging pests such as mealybug and armyworm have been seen in 1998/99, 2016/17 and 2015/16. There is no proven remedy for mealybug or *Heliothis* moths, and research continues in public institutions to understand and develop treatments for these pests.

The leaf miner *Tuta absoluta,* introduced in Zimbabwe in 2016, has resulted in huge losses in the field. Most lossess have occurred in horticultural crops (solanaceous), for which it appears to have a preference, although it can prey on non-horticultural crops such as tobacco. Little research has focused on combating this pest in Zimbabwe, and the extension services have been of little assistance to farmers. All of the chemical formulations currently manufactured in the country have lost effectiveness after each spraying, as *Tuta absoluta* develops resistance at a rapid rate. Producers are therefore reluctant to invest in planting tomatoes and are resorting to other horticultural crops such as leafy green vegetables, causing shortages of tomatoes in the domestic market. False codling moth is another new horticultural pest that is difficult to detect and has restricted the export of produce from Zimbabwe.

Yellow sugar aphid emerged in 2018, with widespread occurrence and no registered pesticides, although losses are still noted to be minimal at 4 percent. Other emerging pests and diseases causing damage in sugarcane are the African sugarcane borer (*Eldana saccharina*), ratoon stunting disease, sugarcane smart, and black maize brittle, whose population is starting to increase due to mixed farming systems among A2 farmers.

Other new pests and diseases may eventually arrive in Zimbabwe from neighboring countries. The most relevant threat is Maize Lethal Necrosis Disease, which can cause very high losses in maize production and is present in Kenya and South Africa. The viruses causing the disease cannot be controlled using chemicals. *Chilo saccariphagus*, a moth that is a noted pest in Mozambique, attacks sugarcane. It severely affects plant growth as it kills the growing point of the plant, and all affected plants have to be plowed out. The moth is transmitted through cross-border movement of chewing sugarcane. The potential for the moth to arrive in Zimbabwe is very high, given the frequent informal cross-border movement between Zimbabwe and Mozambique. The government has already set pheromone traps to monitor movement of the moth into the country.

Cattle Production

Weather-Related Risks

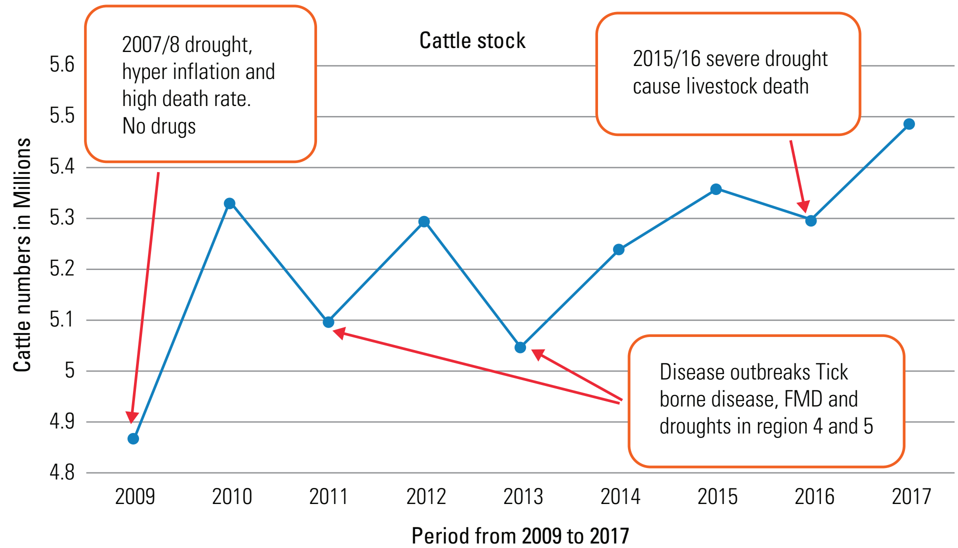
As in crop production, in cattle production the main weather-related risk is persistent drought, especially severe droughts and high temperatures in Regions IV and V every one in five years and in the rest of the country every one in ten years. Drought can cause high livestock mortality, as water sources dwindle while grazing capacity of rangelands declines, mainly in Matabeleland South and North, Masvingo (especially Gutu, Chivi, and Mwenezi Districts), and in Manicaland Province.

Dairy cows in particular are very sensitive to temperature changes, and an increase in temperature is associated with stress and high somatic cell counts. When drought occurs, the amount of feed produced at the farm level declines. Drought also affects the quality of silage, hay, and available forage, thus increasing production costs at the farm level. Since feed costs represent over 70 percent of the variable cost at the farm level, droughts severely affect dairy farming returns to farmers.

Other less severe weather-related risks for cattle are: (1) erratic rainfall distribution, affecting the quality of grazing but rarely causing high mortality if the amount received is sufficient for dams to be replenished and grasses to grow; (2) delayed onset of rains, affecting mostly quality and quantity of grazing pastures, being more critical to cattle in arid regions; and (3) a short rainy season, affecting quality and yields of grazing (one in three to five years), with detrimental effects on animal condition. In dairy production, rainfall irregularities affect silage production. Maize and forage sorghum are major silage crops planted by dairy farmers. If rainfall distribution is not optimal, these crops will not do well and that will increase production costs.

Since animals will be in poor condition because of inappropriate feeding caused by drought, they may

Figure D.8. Effect of Weather-Related Risks on Livestock Numbers (Headcount), 2009–17

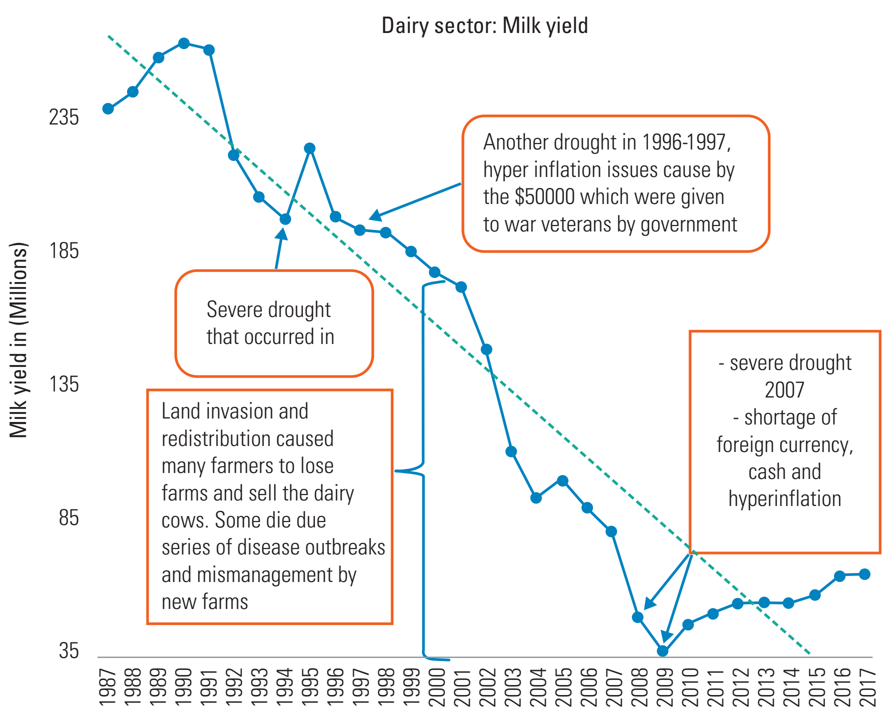


Source: Ministry of Land Agriculture Rural Resettlement of Zimbabwe.

fail to cope with any disease outbreak if these events are associated with high disease incidence. Figures D.8 and D.9 show how production risks over the years have affected livestock numbers and milk yields.

A severe drought, coupled with the introduction of an economic and structural adjustment program in 1991, were seen as the major events that caused the decline in milk production in 1991 to 1994 (Figure D.9). The dairy industry recovered in 1994/95 with a high yield of 223 million liters but was then severely affected by the 1995/96 drought, in addition to the effects of the adjustment program. From 1996, the downward trend was due to macroeconomic policies, drought in 1997, and hyperinflation, which drove most dairy farmers out of business. The downward trend continued as the industry was decimated

Figure D.9. Effect of Weather-Related Risks on Milk Yields, 1987–2017



Source: Ministry of Land Agriculture Rural Resettlement of Zimbabwe.

by a series of disease outbreaks and farm upheavals following land redistribution in 2001 and 2002.

Since about 90 percent of the cattle herd is now found in communal areas in Zimbabwe, smallholder farmers are most affected by the above risks.

Sanitary Risks

Many diseases cause major losses in cattle production in Zimbabwe. Outbreaks of tick-borne diseases are becoming more common, especially in November through January. Both commercial and communal farmers report that ticks are becoming more resistant to local dipping chemicals. An estimated 26,000 cattle died during the 2017/18 rainy season. Heartwater (*Ehrlichia ruminantium*) and January disease (*T.p. bovis*) were the most common tick-borne diseases that killed animals in previous seasons.

Foot and mouth disease is now a perennial challenge, and no vaccines are produced locally. Because of the uncontrolled movement of cattle, the chance of a foot and mouth outbreak are very high, and it will have devastating effects on dairy farming if it occurs. Because of the increase in stray dogs, rabies outbreaks also have a high chance of occurring. Rabies is a zoonotic disease, meaning that it can be transmitted to humans.

A high rate of beef measles was reported by meat inspectors, especially in animals from areas with poor sanitation. The incidence of carcass contamination has increased, and farmers risk losing payment for the whole carcass once the disease is detected.

In dairy production, mastitis is a major challenge. There are no vaccines for this disease, and its spread at the farm level means major losses in terms of milk quality, yield, and revenue.

Poultry Industry

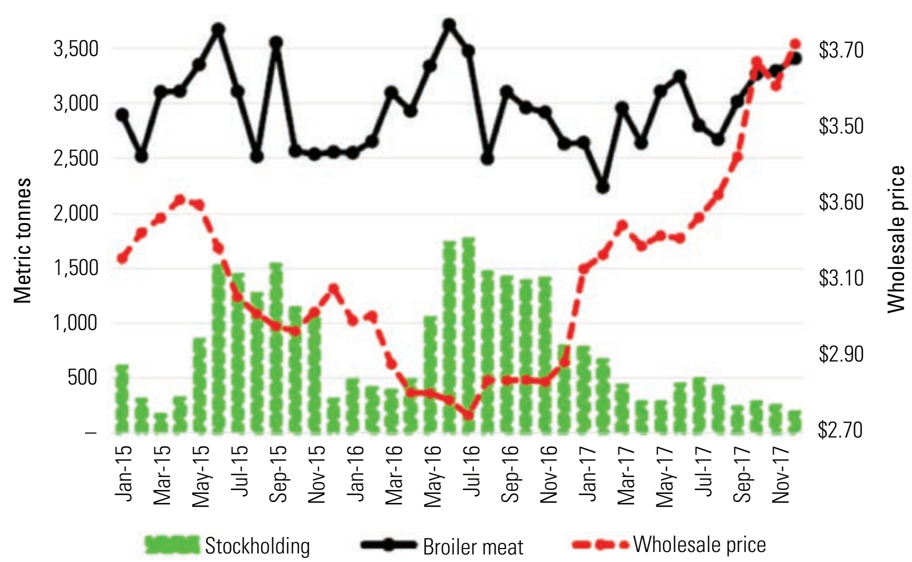
Weather-Related Risks

Drought, disease outbreaks, price volatility, and limited availability of drugs, remedies, and feeds are the main risks affecting the poultry industry. Because poultry production is very in*t*ensive, with a high demand for feed, drought is the major risk affecting the supply of feed ingredients (chiefly maize and soybeans). The risks listed below affect both indigenous communal chicken production and commercial producers.

Production of day-old chicks has increased steadily over the years, with both minor and sharp drops occurring in drought years. There was a decline in poultry production in 1991/92, 1997/98, and 2000-02, and a sharp decline in 2006-09. From 2009 the industry resumed steady growth, with minor setbacks in 2011 and 2013. A major shock occurred in 2015, however, when production of day-old broiler chicks dropped from above 70 million to less than 40 million in response to a drought that reduced feed availability. Broilers are very sensitive to temperature changes, and an increase in temperature is associated with high mortality. Variations in the poultry meat price are clearly related to changes in stocks of animals (Figure D.10).

As in the other subsectors, uncertainty about foreign exchange availability is an enabling environment risk.

Figure D.10. Poultry Meat Supply and Stocking Capacity, 2015–17



Source: Zimbabwe Poultry Producers Association.

Notes

1. The coefficient of variation measures the relationship between the variability of the variable (standard deviation) and the size of the arithmetic average; expressed usually as a percentage. A greater value of the coefficient of variation indicates that greater heterogeneity is present in the values of the variable, and the smaller the coefficient of variation, the more homogeneous are the values of the variable.

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