GCRFAFRICAP
CLIMATE SMART AGRICULTURAL DEVELOPMENT

Zambia's Agriculture and Food System: A Scenarios Analysis

REPORT ON THE GCRF-AFRICAP PARTICIPATORY SCENARIOS WORKSHOP

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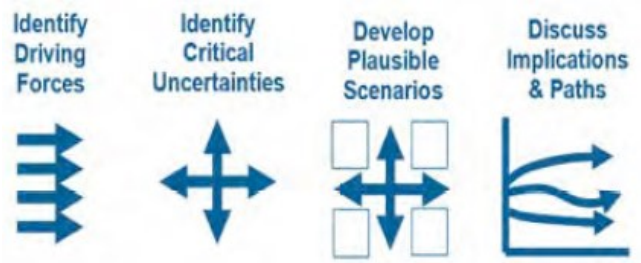
Executive Summary

Zambia is at an important moment in the development of its national agriculture and food system. The Zambian government is committed to promoting agricultural diversification and commercialization as a principal pathway through which to stimulate economic growth, alleviate poverty and achieve food and nutrition security, but the country remains one of the least food- and nutrition-secure nations in the world. The population is expected to more than double by 2050 and, like many other countries in the region, much of this growth will be in urban centres. As incomes rise and diets shift, Zambia faces a growing 'double burden' of malnutrition: undernutrition and micronutrient deficiencies persist among lower-income households and vulnerable segments of the population, while overweight and obesity rise among higher-income families. Agricultural productivity lags behind national targets and maize continues to dominate national production. With climate change expected to lower crop yields and increase pressure on the country's already inadequate irrigation infrastructure, the Zambian government faces significant challenges to achieving its national policy objectives and delivering food and nutrition security to its growing population.

These trends in social and economic development, urbanization, agricultural development and shifting dietary patterns, among others, will shape the future of the food system in Zambia. Policymakers in Zambia should account for the uncertainty surrounding the future trajectory of these trends and their likely impact on agricultural production and food security in policy-development and decision-making approaches.

To support policy decisions on the future of the country's food and agricultural system, a scenario exercise was conducted with a selected group of stakeholders from government, academia, civil society and the agriculture sector (see Appendix A for participants list). Through discussion—against a list of trends which were regarded as predictable—two impactful trends (or critical uncertainties) were selected that had *high uncertainty* in the way they would develop and shape the food system: the extent to which agricultural production would be connected to well-functioning domestic and international export markets, and whether climate risks, affecting agriculture and trade, would evolve that were similar to today's ("low risks") or throw up unprecedented and unexpected challenges ("high risks"). These critical uncertainties create a 2x2 matrix that frames four potential futures—one in each quadrant. Each one of these futures was then explored, allowing participants to consider the inherent uncertainty the future holds, and understand how choices, decisions and extraneous factors might contribute to very different outcomes.

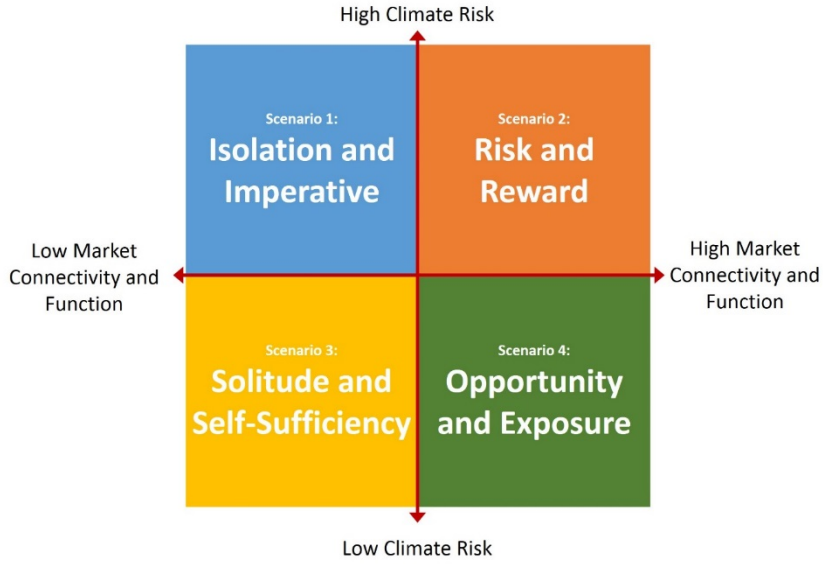
The Steps in a Scenarios Exercise



These four steps define the participatory process. First, driving forces were identified that will shape the future of the food system in a Zambian context, and these were classified into those that are predictable and those that are known to be important, but are less predictable. Of the less predictable driving forces (which are listed in Table 1), two were selected as the critical uncertainties, used to shape the four plausible futures.

The scenarios

Climate change risk and market connectivity and function were agreed upon as the two critical uncertainties that would define scenarios of future agriculture and of the food system in Zambia. A consideration of the plausible extremes of these two uncertainties (i.e. high and low climate risk, and high and low market connectivity and function), and the combinations of these extremes, gave rise to four scenarios:



Each scenario has different implications for the resilience and security of Zambia's food supply, economic opportunity and employment, innovation, and social equality. However, some policy pathways appear to be relatively robust across these varied plausible futures. These promising principles include: the diversification of agricultural commodities and production systems; the strengthening of equitable and just land tenure systems; integrated and cross-sectoral resource planning and allocations (particularly for water, land and energy); inclusive governance systems; and the provision and promotion of skills training in agricultural entrepreneurship.

Introduction: An overview of Zambia's Food System

Zambia is going through an important period in the development of its national agriculture and food system[1]. There is strong political will for the diversification and commercialization of agriculture to stimulate economic growth and achieve food security [1] and for the strengthening of food availability and food markets against a backdrop of population growth [2], urbanization [3] and dietary change [4]. Both the Second National Agricultural Policy (SNAP) and the Seventh National Development Plan (SNDP) identify agricultural development as a key pathway through which to deliver economic development and poverty alleviation.

Despite this, the country continues to rank as one of the least food- and nutrition-secure nations globally [5, 6] and performs poorly against broader human development indicators [6, 7]. A recent country-level assessment of delivery on the Sustainable Development Goals (SDGs) indicates that 46% of the Zambian population is undernourished and 40% of children under the age of 5 are stunted [6]. The national poverty rate is high, at 53.6% [6], particularly in rural areas, and severely constrains access to affordable and nutritious food [8]. Approximately 50% of the Zambian population depends on agriculture for income and employment [8] yet the sector contributes only around 5% of gross domestic product (GDP) [8]. Central to these strategies is a realization of the potential for intensifying agricultural production and increasing irrigation, so as to produce a surplus for export.

Given the speed with which the world is changing—whether from an environmental, social, technological or geo-political perspective—ensuring the country's food system is sustainable, productive and climate smart and able to meet the country's food security and development needs presents a significant challenge. Numerous important trends will shape the evolution of Zambia's food system. Many of these will be hard to predict and influence, creating considerable uncertainty. Below we briefly consider some of the most important.

[1] A country's food system encompasses the totality of the actors, processes and outcomes arising from supplying food to its citizens. This involves agriculture and supply chains and also the food system's impacts on nutrition, health, well-being and the environment.

Key trends

Projected drivers of food system change in Zambia over the coming decades span social, technological, economic, environmental and political domains. Some of the key recent trends and future projections are highlighted in this section in order to provide context for the consideration of plausible food system futures that follows.

a) Demographic and dietary shifts

Zambia is expected to experience significant population growth in the coming decades, above all in its urban centres. The country has one of the highest fertility rates in the world [9] and, with life expectancy increasing, the population is projected to more than double from its current 17.6 million to approximately 41 million by 2050 [2]. Rates of urban population growth are particularly high in central areas of Zambia, in the cities of Lusaka, Ndola, Kitwe and Mufurila, in part the result of net rural-urban migration driven by high urban employment opportunities [10] and significant foreign investment in urban infrastructure and commerce [11].

Urban lifestyles and growing affluence in cities are driving a change in and diversification of diets in Zambia [12, 13]. Over recent years, the share of food expenditure devoted to maize has decreased significantly for both rural and urban households [4], and divergent trends in food spend have unfolded among low- and high-income households. Among poorer households, typically in rural areas, relative expenditure on vegetables has increased but remains low; among wealthier households, expenditure on wheat, rice, potatoes and animal proteins has increased [4] along with consumption of foods that are high in fat and salt.

Zambia, like many countries around the world, now faces a double burden of malnutrition. As evidence of recognition and commitment to address it, four of the eleven strategic directions of interventions included in the National Food and Nutrition Strategic Plan 2011–2015 have a direct focus on tackling problems of undernutrition and the growing occurrences of nutrition-related non-communicable diseases such as obesity, hypertension, cardiovascular diseases, Type I diabetes and some forms of cancer [14]. These strategic directions are: strategic direction I on prevention of stunting in children; strategic direction 2 on increasing micronutrient and macronutrient availability, accessibility and utilisation through improving food and nutrition security; strategic direction 3 on early identification, treatment and follow-up of severe acute malnutrition and; strategic direction 7 on nutrition-related control and prevention. Dietary shifts among higher-income families have contributed to a rising burden of overweight and obesity [13]. At the same time, in spite of increased agricultural productivity since the early 2000s [15], malnutrition in Zambia remains a significant challenge [6]. Diets among lower-income households are broadly characterized by low-calorie intake [15, 16], lack of variety (despite falling expenditure on maize as a share of food baskets at population level, approximately half of dietary energy comes from maize) [16], and consumption of nutrient-poor foods [17]. Micronutrient deficiencies are highly prevalent, particularly among infants and young children aged 2 to 24 months (for whom vitamin A-, iron- and zinc- deficiencies are especially common [18]) and pregnant women [18].

b) Agriculture and the national economy

The Zambian national economy is growing steadily, and fiscal intervention has been relaxed in response to a recent stabilization of the national currency [19]. The government's aggressive spending programme increased public borrowing in 2014 and 2015 and widened the budget deficit [20]. The deficit reached 6% in 2016; it is expected to decline in the medium term as the government

implements its Economic Stabilization and Growth Program [20]. In spite of economic growth, however, Zambia has one of the highest levels of income inequality globally [21]. Zambia's Gini coefficient, a measure of inequality in terms of per capita income, increased from 0.700 in 1996 to 0.753 in 2004, before falling slightly to 0.741 in 2010 and 0.735 in 2015. Thus, for much of this period the trend was towards increased inequality. The Gini coefficient was forecast to be 0.558 in 2018; then 0.553 by 2030 and 0.537 by 2060 [22]. Over the past 20 years, Zambia's poorest households have experienced the highest rates of proportional growth, but the gap between middle- and high-income households has increased [22]. Self-employment is the most common source of income reported by households. Wage income constitutes 51% of total household income. Wage income is the largest contributor to income inequality in Zambia, followed by non-agricultural self-employment. Gender disparities remain, particularly in employment in middle-income jobs, only 38% of which are held by women. [23]. Female representation in parliament and at ministerial levels has improved since the early 2000s but still falls significantly short of parity with male representation [23].

Zambia's economy is heavily dependent on revenue from its extractive industries; copper mining constitutes 11% of GDP and 70% of national export revenue (but only 1.4% of employment) [24] and, when copper prices fell by 28% in the period 2007–2009, foreign direct investment (FDI) fell by 47% as a consequence [25]. Agriculture, on the other hand, is a major employer but contributes relatively little to GDP. According to the Central Statistical Office of Zambia, 49% of Zambians depend on agriculture for their livelihood and employment, yet agriculture accounts for only around 10% of national export earnings [26]. Since 2000, national development policy has sought to promote economic diversification through investment in the manufacturing and agriculture sectors but the contribution of the agricultural sector to this has fallen over that period from 23.8% in 2000 to 6.8% in 2014 [25].

Reforms to land ownership, through the Land Conversion of Titles Act 1975 and the Lands Act of 1995, have paved the way for greater investment in agricultural land by both domestic and foreign investors. Large-scale investments in sugarcane and soybean production, for example, have followed government investments in the promotion of commercial agriculture, electrification and food processing infrastructure [27]. Commercial agricultural developments have taken a variety of forms, including out-grower schemes and plantations, with varying impacts on local livelihoods [28]. Large-scale acquisitions, despite increasing since 2000, nevertheless account for only 1.6% of Zambia's agricultural land [29] and the sector remains dominated by small-scale (less than 5 hectares) and medium-scale (between 5 and 100 hectares) producers [30]. A recent study estimates that 50% of Zambian agricultural land is owned by medium-scale land owners, often wealthy and politically influential urban dwellers [31].

Land tenure continues to remain highly political in Zambia. The country has a dual system of customary tenure and formal title registration, and there is much political controversy surrounding the relative powers of chiefs and the state to allocate and administer land. Recent attempts at limiting the autonomy of chiefs in land allocation through the new National Land Policy have met with resistance. At the same time, local land users are often found to be excluded from land acquisition processes [32].

c) Productivity and technological innovation in the agricultural sector

Agricultural productivity in Zambia lags behind national targets, hampered in part by inadequate irrigation technology and infrastructure. There are three agro-ecological regions in Zambia: Region I, which covers Southern and parts of Eastern and Western Provinces, is characterized by annual average rainfall of less than 800 mm and covers 12% of the total land area; Region II is characterized

by average annual rainfall of 800-1000 mm and covers 42% of Zambia's land area; and Region III receives, on average, more than 1000 mm of rainfall a year, and covers 46% of the country's land area (mostly in the Copperbelt, Luapula, Northern and North-Western Provinces). Soils in this region are highly leached and acidic. Crop production across all three of Zambia's agro-ecological regions is largely rainfed and productivity remains low relative to neighbouring countries [33]. Average maize yields are approximately 2 tonnes/ha/year [1]; in spite of a target outlined in the SNAP to boost productivity to 3 tonnes/ha/year, relatively little progress has been made in increasing productivity in spite of significant investment in the sector [1]. The SNAP outlines a target of investing in and expanding irrigated agricultural production, as do crop-specific strategies such as the National Rice Development Strategy, but, of the 2.75 million hectares of irrigable agricultural land, only 156,000 hectares are currently irrigated [1].

The Zambian government recognizes the vulnerability and limitations of its current maize-dominated agricultural and food system and has identified crop diversification as a key objective in the SNAP. The policy outlines a broad suite of agricultural innovations and development pathways to promote the adoption of improved crop varieties. Under SNAP, a number of initiatives have emerged, including an e-voucher system established in 2016, that promote greater flexibility and choice with regard to subsidized seeds and inputs [34]. Soybean production has increased significantly since the early 2000s, supported by private investment: between 2004 and 2015, annual soybean production rose from 54,700 metric tonnes to 226,000 metric tonnes. Wheat production has also increased, from 82,500 to 214,000 over the same period [1]. Maize nevertheless continues to be the dominant crop produced in Zambia, accounting for between 50 and 60% of all crop production [1]. In the SNAP, it is stated that more than 60% of government spending on agriculture is currently channelled towards maize production and marketing [1]. This is clearly a challenge that the Zambian government should endeavour to overcome, considering that this level of budgetary allocation to maize crop may be interpreted as contradicting the government's quest and commitment to the promotion of crop diversification.

There is significant national and international investment in crop improvement programmes in Zambia, including efforts to build pest and disease resistance and to enhance the nutritional value of crops. These programmes centre principally on four priority crops in Zambia—maize, rice, groundnut, and bean—and are driven largely by the Zambia Agricultural Research Institute (ZARI). Concerns nevertheless remain around the long-term resilience of these crops and the cost of rolling out improved varieties [35].

d) Climate change

Based on 1960–2003 records, mean annual temperature has increased by 1.3°C since 1960, an average of 0.34°C per decade [36]. Moreover, mean rainfall has decreased by an average of 1.9 mm/month (2.3%) per decade since 1960. By 2050, Zambia is expected to experience increases in temperature of up to 2.2°C across the entire country. Projected changes in precipitation are uncertain, both in terms of whether the country will experience increased or decreased precipitation and on how this will differ from one region to another. Models nevertheless tend to agree that extremes of precipitation will become more likely. There will be varied impacts from increase or decrease in rainfall on farming generally and crop production and livestock in particular. Increases in rainfall may result in waterlogged agricultural fields, destruction of crops (in both pre- and post-harvest), contaminated water supplies and increases in incidence of crop and livestock disease. Reductions in rainfall are likely to reduce water availability for both crops and livestock and affect the quantity and quality of pastures. In places where rainfall quantity does not change significantly there may still be changes in season onset and cessation that could negatively affect the production of key crops, including maize, cassava and millet.

There have been few studies that specifically consider projected suitability of crops and agricultural practices in Zambia under changing climates [37]. Broadly speaking, higher temperatures are expected to result in decreased crop durations, lower biomass accumulation and ultimately reduced crop yields [38]. Uncertain rainfall trends may have implications for the productivity of crops, including increased risk of crop failures, and the viability of agricultural practices, particularly in regions where irrigation infrastructure is lacking. Climate-driven hydrological models suggest that the impacts of climate change on water availability will vary geographically, but that there will be an overall reduction in water availability of around 13% by the end of the century [39]. There is significant uncertainty around the relationship between climate change and the incidence of crop pests and diseases—such as fall army worm, soybean rust, maize lethal necrosis disease, banana panama disease and more—which contribute significantly to crop losses in Zambia.

Identifying the most critical uncertainties

As the brief discussion above illustrates, there is considerable uncertainty surrounding how Zambia's food system will evolve between now and 2050. Any 'best estimate' forecast of such a complex system over such a long timeframe will certainly be wrong. Accordingly, plans to develop Zambia's agriculture and food system should be sensitive to this uncertainty. They should allow decision-makers to explore how choices and events might shape different futures and identify strategies that are resilient to uncertainty: no regret options that should pay off in a range of possible futures, rather than the one we hope for or expect.

A scenario exercise can help to do this by exploring the range of possibilities that the future may hold. It identifies two impactful drivers with *high uncertainty* as to how they will develop and create a 2x2 matrix that frames four potential futures—one in each quadrant (see figure 1 below). Each one of these futures is then explored, creating a rich, narrative-driven scenario into which other drivers, with more certainty on how they will develop, can be integrated.

A participatory scenarios workshop engages key stakeholders in a carefully-facilitated four-stage process of: (1) identifying the driving forces of agri-food system change, the key trends in relation to those drivers, and the certainty with which we can project those trends into the future; (2) identifying critical uncertainties, those drivers that are both uncertain and collectively identified as the most important in shaping the agri-food system; (3) developing a narrative description of the four scenarios represented by combinations of the extremes of the two critical uncertainties; and (4) discuss the implications of policies across these scenarios.

Whilst all of the trends considered above are clearly important in determining whether or not Zambia's food system in 2050 will be sustainable, productive and climate smart, they vary in terms of their uncertainty. For example, whilst there may be some uncertainty about the extent of population growth and urbanization that will occur, there is little doubt that both will increase significantly. However, climate change impacts on agricultural production are highly uncertain.

Workshop participants identified, discussed and ranked in terms of perceived importance, the following shortlist of uncertainties for Zambia:

Uncertain Trends	Key Questions	Ranked Importance
Climate change risks	• How will climate change affect agricultural production and the suitability of crops in different regions of Zambia? • Will adaptation efforts be effective in the face of such uncertainty? • Will international efforts to address climate change be successful?	1st
Agricultural trade and markets	• Will Zambia export and import agricultural and/or food commodities as part of a connected system of regional and/or international trade? • Will domestic markets function effectively such that supply and demand dynamics are responsive? • How will supply and demand dynamics affect price stability and	2nd

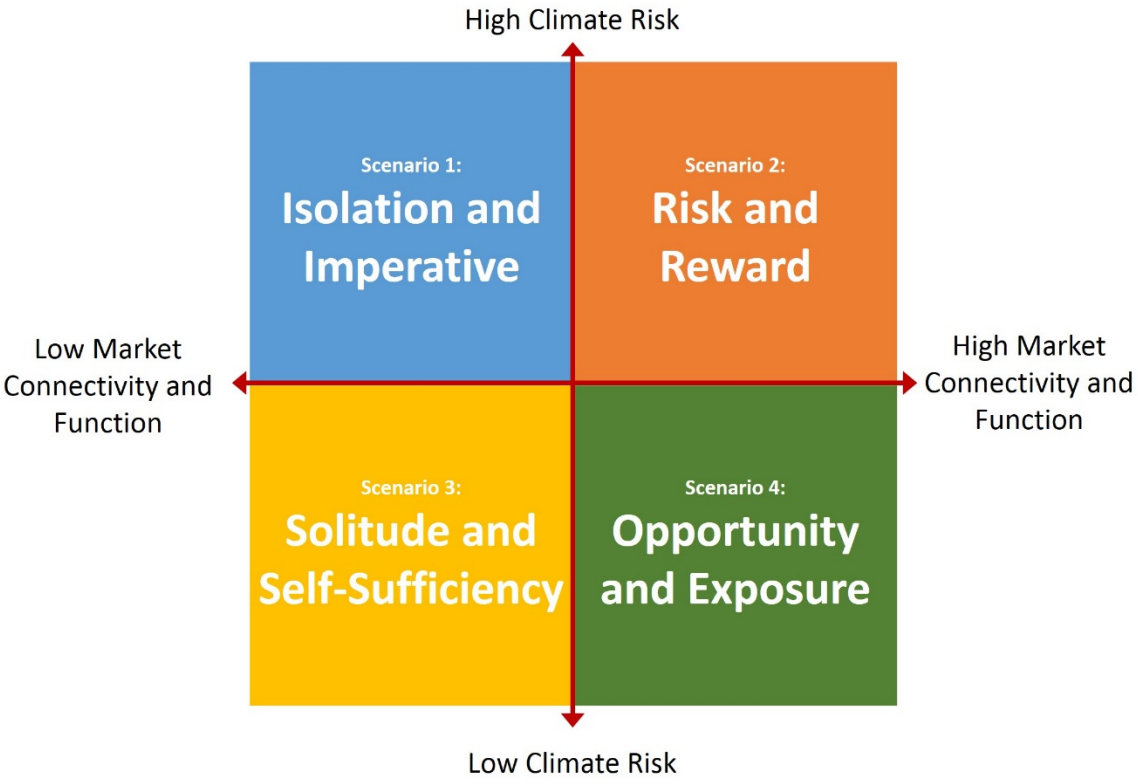
	affordability of food and agricultural inputs?	
National economic growth	• Will trends in national economic growth continue? • Can economic growth stimulate investment in agriculture and the food system?	3rd
Governance	• Will regional alliances be strengthened and food regulation and trade continue to be harmonized? • What degree of political voice will be afforded to stakeholders from across food value chains, both nationally and internationally?	4th
Technology adoption	• To what extent will new innovations in agricultural production be adopted and transform production? • Who will be in a position to access and benefit from technological developments?	5th
Shifts in global geopolitical power	• How will geopolitics and international relations play out? • How will changes in these dynamics affect international agendas and investments, markets and prices?	
Educational attainment	• Will levels of education attainment and the acquisition of relevant skills for agriculture and business improve? • Can education stimulate novel and innovative agricultural business?	
Gender equality	• Will gender inequalities in land tenure, labour burdens and market access persist? • What will greater equality mean in relation to agricultural productivity, food access and nutrition?	
Land tenure	• Can land rights and ownership for rural populations become more secure? • Will foreign investment and large land acquisitions displace or disinherit rural households? • What implications will land acquisitions and changes in tenure have for poverty and food access amongst the most marginalized?	
Dietary change	• How will the nutrition transition play out in Zambia? • Will traditional diets and foods be preserved, or will western diets and processed foods be adopted? • Will diets be diverse and nutritional? • How will the nature of malnutrition evolve among different sections of society?	

Table 1: Drivers of change discussed by participants at the workshop

The scenarios

Based on the ranked importance of uncertain trends presented above, it was determined that the most important uncertainties for future scenarios in Zambia are: (1) market connectivity and function, and (2) climate change risk. The key uncertainties can be used to describe four plausible futures that are very different, defined by combinations of market and climate risks. The resultant scenarios are illustrated in figure 1 and discussed below.

Figure 1: Four scenarios for the future agriculture and food system in Zambia



In developing a narrative of what each of these scenarios looks like, particular attention was paid to the following questions:

- What are the implications of the scenario for agriculture (and its technologies), crops and farming systems, trade, nutrition, employment, food prices, sustainability, economic growth?
- What might be the implications for different stakeholders and who are the likely winners and losers?
- How might such a world come about between now and 2050?

These questions are considered in relation to each scenario in the following discussion.

Scenario 1: Isolation and Imperative
(High climate risk, low market connectivity and function)

This future sees Zambian agricultural and food markets functioning poorly, characterized by unstable supply and fluctuating market prices and without significant increases in import and export trade. It is also a scenario of high climate risks in which increased temperatures and global climatic processes have resulted in more extreme and less predictable rainfall patterns, associated with increased risk of droughts and floods, and associated pest and disease burdens, environmental degradation and health consequences.

In this future, climate risks were not well characterized by models in 2019 and developed more quickly than was anticipated. In addition, global climate change action was slow and insufficient. Zambia has not achieved sufficient commercial growth (or sufficient investment) to increase its international trading capacity, and regional and global trading agreements (such as the Southern African Development Community-SADC) have broken down and been replaced by protectionist policies and trade barriers in the country. Unstable climatic conditions have limited capacity to sufficiently and consistently increase agricultural productivity in order to facilitate participation in international trade in food. Additionally, high climate risk regionally and internationally has resulted in a high degree of variability in the quality, quantity and price of Zambia's food imports.

Greater climate variability has resulted in less reliable growing seasons, more frequent extreme weather events, and new and more extreme pest and disease outbreaks [40]. Adapting to these risks has depended to an extent on the roll-out of new forms of agricultural systems but, owing to low market connectivity, investments in modern agricultural techniques and national agricultural research have been relatively low. There has thus been a concurrent trend towards more traditional and more resilient forms of agricultural production, based on open-pollinated crop varieties and diverse agro-ecological production. Production remains labour-intensive and the agricultural sector continues to provide employment and livelihoods to a growing population.

In order to avoid a trade deficit and economic stagnation, Zambia has had to find ways to produce sufficient quantities and diversity of food to feed its growing population and cater to their changing diets. But in the context of high climate risk, domestic productivity has struggled to keep pace with demand. Improvements to irrigation infrastructure made under SNAP have provided a means of buffering the impacts of reduced or late-onset rainfall events, but severe droughts are affecting water availability and limiting the coverage and reliability of irrigation systems. High local climate risks have seen local markets, as well as international ones, become less effective: in good periods markets are flooded, and in bad years, there is insufficient food to meet demand. Households are increasingly producing food for subsistence purposes rather than to trade.

Reduced market connectivity and unfavourable agro-climatic potential has resulted in falling FDI in land and infrastructure. Zambia has had to become more self-reliant in catalysing commercial agricultural growth and in regulating biosafety, food safety and trading standards—all of which are intended to ensure sustainable supply of food products reflecting national needs and preferences. A more internally-led process of growth has helped to deliver a food system that is better tailored to national needs, with profits being reinvested in sector development rather than being reaped by foreign investors.

Those farmers who have been able to diversify their production to serve the changing diets and demands of national consumers, whilst also becoming more resilient to climate risks, have gained a

competitive advantage. Smallholder farmers, who are disconnected from markets and who are particularly vulnerable to climate extremes, and large-scale commercial producers, who are export-orientated and who have limited flexibility in their production systems, have emerged as the 'losers' in economic terms in this scenario while urban-elite medium-scale landowners have benefited. For consumers, the availability and price of food is highly variable, fluctuating with local and national production conditions, and the trend towards 'westernized' diets witnessed in urban areas in the late 2010s has slowed considerably.

Scenario 2: Risk and Reward
(High climate risk, high market connectivity and function)

In this scenario, Zambia's food system is highly connected and markets are well-functioning but climate risks are high. Zambia is now exposed to warmer conditions and more extreme rainfall patterns, more frequent floods and droughts and higher incidences of pest and disease outbreaks. [40]. Climate risks are greater than were anticipated in 2019 and climate change policies have failed to deliver Paris-compliance. Despite uncertainties in the early 2020s, where protectionist policies emerged with the development of inward-looking nationalism, the need for well-functioning markets re-emerged as a key concept in the second half of the 2020s and global liberalized market development continued apace, leading to strong, stable and frictionless global trade by 2030.

Zambian production is now dominated by those crops in which it has a competitive advantage in the global market and is more homogenized than it was in 2019. This homogenization has increased reliance on trade from regional and global markets and, in years of significant climate disruption, Zambia's food supply has suffered shocks. Investment has been targeted at crops with relatively high drought-resistance, including cassava, and smaller livestock such as chicken have displaced much of the farming of larger livestock such as cows that are more exposed to climate extremes. The government has had to introduce sustainable resource management plans for water and energy use, as well as Integrated Pest Management and efficient irrigation systems. The 'winners' in the agricultural sector are those most able to adapt to climate risk: large agribusinesses backed by FDI are able to leverage their economies of scale and adapt to more challenging conditions, as are those producers who maintain agro-ecologically diverse systems at small scales and are less dependent on market access.

The private sector has benefited from high market connectivity. The food system is now dominated by larger agribusinesses; smallholder farming is minimally viable, in economic terms, in a market that favours technical expertise. Consolidation and mechanization of farming has led to lower employment opportunities in rural settings and continued rural-to-urban migration. With production now dominated by large-scale farms and reduced crop diversity, extreme events or associated pests and diseases are also impacting severely on crop yields. Greater dependence on agricultural inputs and technologies together with more frequent supply shocks have driven up food prices and prompted greater price volatility.

In order to deliver food security for a growing population, the Zambian government has developed its trade policy to complement domestic production, importing greater volumes of fruits and vegetables to supplement domestic cereal production. High climate risk has, though, led to more volatile global production and more frequent food price spikes and supply shocks. With the national food system now closely integrated with international markets, consumers are highly exposed to high prices and food shortages.

Scenario 3: Solitude and Self-Sufficiency
(Low climate risk, low market connectivity and function)

In this scenario, climate risk is low but Zambian markets are functioning poorly; prices are volatile, demand and supply are unsynchronized, and consumers lack access to goods. The national food system is disconnected from global and regional trade. Global action towards achieving Paris-compliance was effective and timely but regional and global trading agreements (such as SADC) have broken down and been replaced by protectionist policies.

While there is limited market impetus for increased agricultural production, a growing population with shifting dietary preferences is prompting an increase in overall demand and incentivizing a diversification of agricultural production. Food prices are affected by domestic harvest conditions rather than global supply and demand, and domestic production is fairly stable owing to relatively benign climate conditions. Farmers and markets across Zambia are closely connected and farmers and food producers have emerged as important drivers of economic growth through investing in value chain development and greater market access. However, all the positive steps and signs observed domestically in terms of diversification in agricultural production, an increase in overall demand, price stability and internal market connectivity do not translate into remarkable agriculture-based economic growth. Zambia therefore witnesses economic stagnation principally caused by a reduction in exports and FDI. With population growth driving the need to produce more food for local markets, there is more pressure on land, which leads to encroachment into fertile forested areas.

A stable climate and investments in agricultural technologies and irrigation have created favourable conditions for new agri-business and agricultural innovation, but the insular nature of Zambian markets has discouraged foreign investment. Reduced FDI in domestic infrastructure has created problems in the distribution of food, and logistical challenges hamper the movement of commodities from areas of surplus to areas of deficit. Zambia has nevertheless harnessed its abundant natural land and water resources to become nationally self-sufficient in food and energy (including through the deployment of hydropower), supported by home-grown enterprise and targeted government investment. More local forms of self-sufficiency have also emerged based on small-scale, resource-efficient production and relatively low levels of consumption.

In the absence of greater economic growth, there are more losers than winners in this scenario. Specifically, agricultural innovators may emerge winners by targeting diversified dietary trends domestically while vulnerable smallholder farmers with limited to no access to improved food systems innovations will be losers. Among the action that needs to be taken now, there are calls to reduce the subsidization of maize production in order to achieve diversification in crop production and to respond to new food demand as reflected in increased dietary shifts. Furthermore, land tenure security—especially for smallholder farmers—should be strengthened and there is a need to engage in campaigns to promote local foods. Other action that could be taken now includes creating a policy environment that can ensure effective investment in export commodities, the opening up of borders and removal of trade restrictions alongside increased investment in national infrastructure to facilitate the movement of goods, thereby strengthening domestic markets.

Scenario 4: Opportunity and Exposure
(Low climate risk, high market connectivity and function)

In this scenario, climate risk is low and Zambia has developed well-functioning markets in which supply is highly responsive to demand and consumers are able to meet their needs. The national food system is well connected to regional and international trade. Global action towards achieving Paris-compliance was effective and timely, international efforts to secure and strengthen trade agreements were successful and Zambia benefited from a vibrant and productive domestic economy.

Zambian agricultural production is orientated around those crops in which it has a comparative advantage. One specific area in which Zambia has comparative advantage is maize production. As a result, unless the diversification policy gains impetus from government support and private sector investment, there is increased maize production. Maize that is surplus to domestic demand (human consumption, agro/industrial processing and animal feeds) is exported thanks to the well-connected regional markets. The enhanced food system and agriculture-based economic activities result in more tax revenues to the government, enabling increased investment in health and education. In response to shifting dietary preferences around the world, Zambia's agricultural exports now reflect consumer demand for more sustainable diets; thanks to abundant natural water resources and government investments in improved irrigation infrastructure, these exports include irrigable tropical food crops. Relatively stable climatic conditions have provided an opportunity for increased production of a diverse range of food crops and for the expansion of commercial agricultural. FDI in large land acquisitions and agricultural production technologies has, in turn, increased. Improved availability of a variety of food products has accelerated the trend towards diversified and 'westernized' diets, bringing both health benefits (e.g. in terms of micronutrient access) and costs (including a rise in non-communicable diseases-NCD).

Greater market connectedness of agricultural supply chains has worsened inequalities in the agricultural sector. Smaller-scale producers that do not enjoy the same economies of scale as their larger counterparts have mostly struggled to remain economically competitive in export-driven markets, though there are those who have successfully adapted either by tapping into niche markets, by organising into collectives or by adopting more novel production systems. Increased export trade has increased non-farm employment opportunities across supply chains, including in processing and transport. Stable climatic conditions have also provided an opportunity for subsistence farmers to pursue diverse crop production and associated improvements in nutrient supply. However, the flipside of the low risk and stable climatic conditions is that the government and other actors are in a state of lethargy, with no actions undertaken to build resilience to climate shocks despite significant investment in the adoption of new farming techniques and other food systems innovations and technologies (crop breeding, seed production, agro processing). There is some degree of complacency concerning the impacts of climate change on the agricultural sector, which leave Zambia unprepared to any unexpected climatic shocks.

Food prices and agricultural input (including fuel) prices are determined by global dynamics of supply and demand, and economically marginal producers and consumers are highly exposed and vulnerable to periodic price shocks and international supply, although these are fairly infrequent. Smallholder farmers—already disadvantaged by a lack of financial and technical means—are among the losers in this scenario because they are not able to take advantage of the regional and international market connectivity and are still limited to subsistence-level production. As considerable efforts are deployed in general production for export, and maize production in

particular, local consumers are losers through a lack of diversified food products in local markets. Traditional farmers and the crop-breeding research community also stand to lose with the loss of indigenous knowledge and nutritious indigenous foods. However, largescale farmers and private sector actors, with their abilities to access investment opportunities and high-tech agricultural production tools, are among the winners, as are technology developers. Society as a whole and consumers in general win in so far as innovative technologies yield more, affordable and accessible nutrient-rich food.

Policy Implications

The descriptions of the four scenarios have exposed the magnitude of uncertainty as to how the agriculture and food system of Zambia will evolve over the next decades leading to 2050 and beyond. Successful development of the food system in Zambia requires co-ordinated thinking about the way climate change will impact domestically and internationally, through trade's sensitivity to climate impacts elsewhere[41]. Furthermore, it requires co-ordinated investment in the agri-food sector and its supporting infrastructure, and a deliberative linkage between domestic production, imported food and nutrition.

In this context of high uncertainty, what are the implications of policy decisions made today and what policy decisions are robust across the four scenarios? Some of the implications, arising from discussions at the scenarios workshop, include:

- Diversifying agricultural production and production practices brings benefits both in terms of climate adaptation and the creation of new market opportunities, as well as offering potential benefits for improved nutrition and greater dietary diversity. Steps have already been taken to delink subsidies from maize production. This is important, as such subsidies may inhibit diversification and distort competitive advantage in other crops, particularly in a context of more connected markets. Alongside diversification, there is a need to invest in strengthening the resilience of production systems to stresses through land management practices that conserve soils and address environmental degradation. An overly technocratic approach, based on narrow assumptions about the performance and suitability of 'silver bullet' practices, however, is likely to compromise resilience and bring livelihood challenges. Furthermore, the scenarios illustrate that changes in climate risk and market connectivity may significantly change the market "pull" for different crops and that stimulating investment in a greater range of products may provide resilience against future uncertainty.

- Robust and well-functioning land tenure systems will be important in contexts that might see more investment in agriculture and land. Poor land administration regulations can leave small rural landowners particularly vulnerable to displacement and negative livelihood outcomes. Access to food and markets is important to all, whether these markets are domestic or international, and investing in infrastructure that promotes this access is important, although care should be taken to make sure these investments are also equitable. Representation and participation in land, agriculture and market governance, particularly of those typically underrepresented, will be important for ensuring equity.

- The agriculture and food system in Zambia is intrinsically linked to water, energy and health sectors. Integrated planning across these sectors is important for avoiding contradictory plans or over-allocations of water, for example. In contexts of uncertainty (e.g. about future water availability) building contingency into sectoral strategies will be particularly important in strengthening long-term resilience.

- It is clear that across the scenarios, high climate risk brings little benefit, so efforts to limit warming are important, but the extent to which Zambian national activity can influence this is limited given that it accounts for approximately 0.1% of global emissions [42]. However, through its participation in international climate agreements and the African Group, Zambia can continue to push for global climate action and justice.

- Having a skilled, entrepreneurial and innovative agricultural labour force brings benefits across all scenarios in terms of adapting and making use of new market opportunities and facilitating the diversification of the agricultural sector. Emphasizing agricultural and business skills within the national curriculum and promoting agriculture and business programmes within further education can contribute towards building this skills base.

Key Questions for Further Consultation

To be asked of a broad range of key stakeholders across the agriculture and food sectors in Zambia, for input into further iterations of the report:

- Descriptions of future scenarios are inevitably subjective, do you agree with the descriptions of the four scenarios presented above, and what would you add or change about them?
- Which scenarios do you see as being more or less desirable for the Zambian agriculture and food sector?
- What policies or strategies do you believe are advantageous and robust across all (or most) scenarios?

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