TRANSFORMING AGRIFOOD SYSTEMS IN ZAMBIA

What Are the Priorities and How Much Will It Cost?

July 2025

FOREWORD

As Zambia strides towards sustainable development, the nation faces the dual challenge of transforming its food systems while ensuring economic, social, and environmental sustainability. The imperative to achieve the Sustainable Development Goals, particularly SDG 2 which aims to end hunger, achieve food security, improve nutrition, and promote sustainable agriculture, is more critical than ever.

This report, Transforming Agrifood Systems in Zambia: What are the priorities and how much will it cost?, produced by the Shamba Centre for Food & Climate under the auspices of the Zero Hunger Coalition, provides an evidence-based, costed roadmap for integrating effective interventions into national policy and programs. It is a product of collaborative efforts involving key stakeholders such as the National Food and Nutrition Commission, FAO, IFPRI, and various governmental and non-governmental partners. Together, we have embarked on a journey to not only address the immediate challenges but also lay down the stepping stones towards long-term sustainable goals.

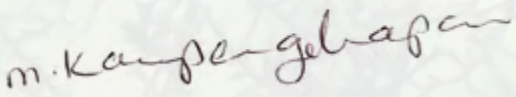
Our collective endeavour has been to understand the economic, social, and environmental facets of food systems transformation. Through a series of inclusive workshops and consultations, we have identified and prioritized interventions that are both impactful and necessary for Zambia. These interventions span across ensuring access to safe and nutritious food, shifting to sustainable consumption patterns, promoting nature-positive production, advancing equitable livelihoods, and building resilience against climate change and other shocks.

The pathways and interventions outlined in this report are informed by robust analytical work and stakeholder engagements. They are designed to address the current challenges highlighted by recent adversities such as the pernicious drought of 2024, which severely impacted the livelihoods and food security of our farmers and the general population. The strategic choices and investments we make today will determine the future of our food systems and their capacity to support a healthy, prosperous, and resilient society.

The forward momentum requires unwavering support and coordinated action from all sectors of society. It is imperative that we, as a nation, mobilize resources, foster innovation, and implement these strategies with rigor and dedication. As we present this report, we invite all stakeholders to join us in this transformative journey, ensuring that our policies and investments yield the desired outcomes and truly make a difference in the lives of all Zambians.

We are grateful for the contributions of each individual and organization involved in this significant undertaking. Together, we are setting the stage for a food-secure, nutritionally adequate, and environmentally sustainable Zambia by 2030.

Dr Muntanga Kampengele-Mapani
Executive Director, National Food and Nutrition Commission



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Transforming Agrifood Systems in Zambia: What Are the Priorities and How Much Will It Cost?

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EXECUTIVE SUMMARY

Zambia is not on track to achieve the United Nations Sustainable Development Goals (SDGs) by 2030. Its lack of progress is further exacerbated by the country's maize-centric and rain-fed agriculture sector that is vulnerable to recurring drought cycles predicted to worsen with climate change. At the time of writing this report, Zambia once again is in the grip of a severe drought that destroyed close to half the country's crops. To get back on track, it is critical to pursue policy pathways that favour synergies and limit the trade-offs between hunger, poverty, nutrition, and climate change. This report presents an evidence-based prioritization of effective interventions to operationalize Zambia's Food Systems Transformation Pathways to end hunger, make diets healthier and more affordable, improve the productivity and incomes of small-scale producers, and mitigate and adapt to climate change.

Without additional investment, significant levels of hunger, malnutrition, and poverty will persist after 2030. By 2030, economic growth in Zambia will be insufficient to reduce the number of people affected by hunger and poverty. Without additional investment and more effective policy interventions, the poverty rate in 2030 will remain high at just over 60%, while the hunger rate will decrease very slightly to 30%. Healthy diets are and will continue to be unattainable for more than 80% of Zambians by 2030.

Zambia could achieve its SDG 2 (Zero hunger) targets by 2030 by increasing public investment by USD 3.5 billion per year, largely in the form of social protection programmes, such as cash transfers. The prioritization of cash transfers over and above more longer-term systemic interventions is due to the 5-year countdown to 2030.

However, this level of spending and the funding of food systems transformation through cash transfers is not sustainable. Not only is the level of spending needed high, but a prioritisation of cash transfers will result in the underfunding of effective longer-term interventions that are critical to achieve sustainable and long-lasting food system transformation. The shortfall in longer-term funding will increase Zambia's vulnerability to shocks and crises, pushing up the number of people affected by hunger and poverty.

Neither is narrowly investing in maize the answer. At the specific request of the leadership of Zambia, the report also modelled the investment required to double maize yields by 2030 to develop a better understanding of the trade-offs of pursuing an aggressive expansion of maize production to address domestic food security as well as drive exports. Whilst demonstrating positive increases in GDP and yields, this investment strategy results in smaller gains in hunger and poverty and risks poor nutrition due to the crowding out of more diverse and nutritious crops.

Alternatively, it is possible to achieve a sustainable food systems transformation in the next 10 years with an additional public investment of USD 1.9 billion per year from 2024-2035. This should be allocated to longer-term development priorities in order to support resilience building that would help mitigate against future shocks and crises as well as maintain greenhouse gas (GHG) emissions in agriculture to Zambia's nationally determined contribution (NDC) goals, and increase resilience to climate change.

Critically, achieving sustainable food systems transformation is not just about the volume of spending but how the spending is allocated. The complexity of the interrelationships among the key food system challenges requires a balanced mix of interventions. Food system interventions should, therefore, not be considered as isolated fixes but rather as an integrated portfolio designed to meet complex objectives.

The report recommends the Government of Zambia and its development partners:

|1| **Urgently and significantly increase public investment** by an additional USD 1.9 billion per year from 2024 to 2035 to achieve the transition to sustainable food systems. This will reverse the severe underfunding of longer-term agricultural investment needs and will help achieve food security and nutrition.

|2| **Increase spending across the agrifood system** both on and off the farm and through social protection programmes. An additional USD 620 million per year on average is needed to improve farm productivity and incomes; an additional USD 740 million per year on average is needed for social protection, education, and school feeding programmes; and an additional USD 550 million per year is needed to move food to markets.

|3| **Accompany on and off-farm investments with nutrition-sensitive interventions to achieve multiple and complementary outcomes.** To achieve multiple and complementary outcomes, on- and off-farm investments should be systematically aligned with nutrition-sensitive interventions. Priority must be given to the operationalization of Zambia's Food-Based Dietary Guidelines, supported by agricultural actions that promote dietary diversity. Nutrition education initiatives, along with guidance on food storage and preparation, are essential to enhance the impact of social protection schemes and agriculture programmes. This includes integrating nutrition considerations into food banks, school feeding initiatives, and safety net mechanisms.

Off-farm investments must also facilitate access to markets to support livelihoods and improve dietary options. In this context, addressing the over-reliance on maize in both urban and rural diets is essential for shifting towards more diverse and nutritious consumption patterns. Zambia's experience with the Scaling Up Nutrition – 1,000 Most Critical Days Programme offers valuable lessons for implementing coordinated, multi-sectoral approaches to reduce stunting and improve nutrition outcomes.

|4| **Improve the economic productivity and crop diversity of small-scale food producers as a top priority.** Zambia's policy documents and strategies identify farm-level interventions as a top priority for public financing. These include improving farmers' access to high-quality inputs, including seeds, fertilizers, and technologies, along with greater access to mechanization , digitalisation tools, markets, and extension services. Key advisory components include the promotion of local crops, agro-ecological practices and sustainable soil management. Also critical is the diversification and expansion of crops, small livestock and fisheries to build resilience and enhance food security. Such interventions seek to enable smallholder farmers, who constitute the bulk of agricultural producers in Zambia, to address productivity gaps and adjust production practices to climate change impacts. Importantly, these interventions must be carefully designed to reflect gender-specific barriers and ensure equitable benefits for vulnerable groups.

|5| **Prioritise addressing existing gender inequalities in agriculture.** In Zambia, women provide 62% of agricultural labour. This needs to be addressed and reflected in policies and strategies. Primary points of intervention are the need to address insecure tenure and widows' rights, ensure women participate in decision-making at all levels, reduce their work burden, provide them with access to and supporting their use of productive resources, such as agroclimatic information, technology, livelihood incomes and credit opportunities, and support collective action by women's groups.

|6| **Ramp up efforts to address the effects of climate change and variability, which are already undermining Zambia's ability to become food and nutrition secure.** Zambia's mostly rain-fed agriculture is vulnerable to the impacts of increasing rainfall variability, recurring droughts, and rising temperatures. The country must therefore ensure that climate resilience and adaptation are integrated into agricultural and food system policies and programmes. Key steps to address climate change have been taken in both national policy and many donor-funded initiatives emphasise the need to build resilience. However, a scaling up of ef-

forts is needed to promote climate-smart agriculture through targeted extension services, improved crop choices and drought resistant seeds, and diversification from maize monocropping to limit deforestation. Additional priorities include investment in small-scale irrigation and water infrastructure, early warning systems, weather-based cash transfers, agroforestry practices and technologies, as well as better access to climate resilient animal feed and breeds. Taken together, these measures will help protect soils and biodiversity, conserve water, and limit land degradation.

|7| **Better address the contribution of the livestock sector to total and per capita GHG emissions which will continue to rise by 2030.** The most significant area of growth and share in the total GHG emissions in Zambia to 2030 will be from increased livestock production. Existing livestock policies do not build on synergies with climate change mitigation targets and adaptation plans, focusing primarily on breeding, veterinary services, and necessary infrastructure investment. While such investments are part of the mix, to create a prosperous and sustainable livestock sector, policies should also prioritize manure management and include a focus on small ruminants. Despite its prominence in policy documents, there is inadequate donor focus on sustainable livestock intensification.

|8| **Scale-up sustainable aquaculture programmes.** Considering the significant role of fish and fish derived products in the diets of Zambians, particularly in low-income households, sustainable aquaculture should be prioritized as a nutritious and affordable source of protein. New donor-funded projects should focus on the sustainable development of the fisheries and aquaculture sectors which represents a potential area for high impact investment.

|9| **Invest in interventions to reduce food loss and waste as some of the most effective ways to address the nexus of food security, nutrition, income, and climate change.** There is too little attention given by the government and its development partners to reducing food loss and waste. Focus should be given to interventions and policies that reduce post-harvest losses and improve food safety, such as better infrastructure including road networks and storage capacities. To support the transition to healthier diets, cold storage and preservation of food items, such as vegetables, fruits, and animal products including fish and fish related products, will be vital.

|10| **Provide better support for regional and national institutions to improve the capacity to monitor, analyse, and inform people on progress and achievements.** Such capacities are critical to monitoring the food systems outcomes of investments in the portfolio of interventions, including better-disaggregated data to account for subnational and gender differences.

INTRODUCTION

Agriculture and food systems in Zambia face key challenges, despite important improvements in the past decade. The number of people affected by hunger declined from one in two people (54%) in 2008 to one in three people (30%) in 2021 (see Figure 1). However, Zambia's maize centric food system coupled with more frequent and severe drought cycles and floods, have resulted in diets that are nutritionally poor and incomes that are increasingly precarious, especially for the small-scale producers that depend on rain-fed maize crops (AfDB, 2023a). Many are malnourished due, in part, to the lack of diversity in their diets and the unaffordability of diets with 80% of people unable to afford a healthy diet (FAO, 2023a). Zambians consume the most maize per capita in the world, exacerbating malnutrition, particularly among women and children (AfDB, 2023b). Diets for both low- and high-income households remain dominated by starches and are lacking in vegetables, fruits, and animal-sourced foods.

The high levels of maize consumption can partly be attributed to vast farmer input subsidy scheme which, whilst ensuring self-sufficiency in maize production and contributing to improving food security, has disincentivised the diversification of crops, and failed to address the significant market failures in the agriculture sector (Kuntusha & Mwlewa-Zgombo, 2022). Worse, despite the input scheme, maize yields remain low compared to other countries (see Figure 6). In 2020, maize yields in Zambia were less than half the average for Southern Africa and four times lower than the United States (the country with one of the highest maize yields) (FAO, 2024).

Nevertheless, the overall economic situation in Zambia has improved and there is rising urbanization and access to supermarkets, albeit uneven. Spending on fruits and vegetables, animal source foods, fats and sugars, and processed foods has increased, more so in urban areas, and more so for high-income households. Rising incomes have also contributed to a steep rise in beef production to meet the increase in demand (FAO et al., 2022). But with these changes has come rising levels of overweight and obesity, increasing by 80% since 2008, with women twice as likely to be affected by overweight and three times as likely to be affected by obesity than men (see Figure 11).

The change in incomes and diets in the past decade is also associated with worsening environmental challenges, particularly deforestation. In 2021, for example, the annual deforestation rate in Zambia was estimated at 300,000 hectares per year, amongst the highest in the world and a significant contributor to greenhouse gas (GHG) emissions after charcoal production (IMF, 2023). Agriculture and land use change account for more than three quarters of GHG emission sources in Zambia (see Figure 4) (WRI, 2023). If Zambia continues with business-as-usual, it will not meet its emission reduction goals as set out in the country's NDC (World Bank, 2019). Moreover, the agriculture sector is not only a driver of climate change but is also highly vulnerable to the effects of present and future climate change impacts.

Importantly, Zambia is home to global public goods such as forests, woodlands, and grasslands that are needed to address climate change, preserve biodiversity, and achieve the United Nations Sustainable Development Goals (SDGs). Transforming food systems to deliver on hunger, poverty, healthy diets, and climate change while safeguarding global public goods will require significant efforts and resources and therefore global solidarity—in other words, more external aid.

Zambia has ambitious plans to reverse these trends; from its global commitment to Agenda 2030 and the Sustainable Development Goals (SDGs), to its recent adoption of Zambia's Food Systems Transformation Pathways: The Road to 2030 (2023a), and a plethora of other policies and targets on agriculture, food security, nutrition, climate change, and the environment.

To support the achievement of these ambitions, this report provides the evidence base and estimated public investment for the most effective interventions that the government and its development partners should prioritize to achieve the goals in Zambia's Food System Transformation Pathways and SDG 2 commitments. The report's findings are based on a machine-learning assisted scoping review of country-level policy documents and peer-reviewed literature, microeconomic analysis of changing diets and food consumption habits, engagement and consultations with in-country stakeholders, and macro-economic modelling using a computable general equilibrium (CGE) model integrated with household survey data. The report is part of the Hesat2030 project that explores the interaction between achieving healthy diets, reducing hunger and poverty, and addressing climate change within the evolving food systems in nine countries – Bangladesh, Benin, Democratic Republic of Congo, Cambodia, Ethiopia, Malawi, Nigeria, Madagascar, and Zambia. It was coordinated through the Zero Hunger Coalition.

Chapter 1:
ZAMBIA'S FOOD SYSTEM CHALLENGES

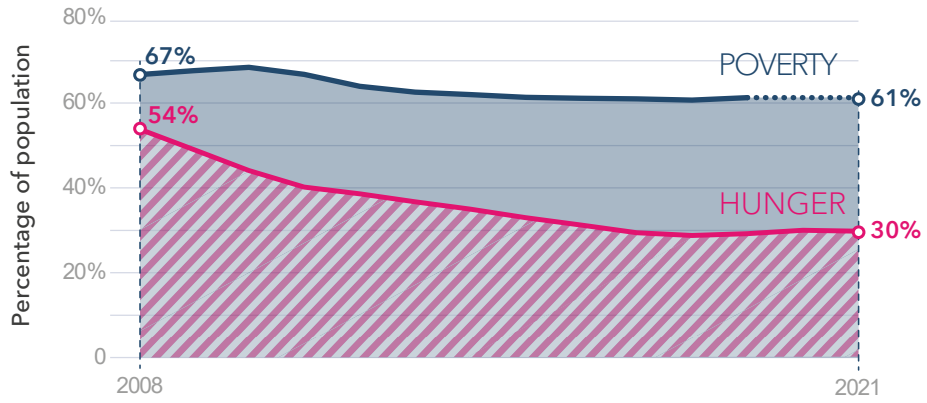
Zambia is not able to adequately feed its growing population. The agricultural sector is characterised by small-scale producers farming maize using traditional practices and experiencing low yields. Whilst the number of people affected by hunger has almost halved in the past decade (WB, 2023a) poverty remains stubbornly high, and food insecurity is on the rise (FAO, 2023a). Structural constraints in the agriculture sector and climate change underpin the prevalence of extreme poverty and hunger, the unaffordability of healthy diets, and dietary composition. Equally, agriculture is a strong contributor to climate change, mostly due to the GHG emissions intensity of agriculture and land use change, particularly deforestation (WRI, 2023).

1.1 Declining hunger but high poverty and demographic pressures

Although there has been progress over the past decade in reducing hunger, poverty remains a pressing issue in Zambia (Figure 1). In 2019, 61% of the population lived under the poverty line in 2019, almost double the average for sub-Saharan Africa at 35% (WB, 2023a). The prevalence of undernourishment is also above the regional average, estimated to be 30% between 2020 and 2022 (3-year average), compared to 22% for sub-Saharan Africa over the same period. Beyond caloric hunger, dietary quality, food insecurity - the unavailability of food and/or lack of resources to obtain food - remains a concern. There are also significant challenges regarding the availability and accessibility of healthy diets. In 2021, a staggering 81% of the population in Zambia could not afford a healthy diet. Comparatively, this is double the 42% of people globally. However, it is aligned to the 83% of people in sub-Saharan Africa that cannot afford a healthy diet (FAO, 2023a).

Whilst hunger has been declining, poverty remains stubbornly high

Figure 1. Prevalence of hunger and poverty in Zambia, 2008-2021

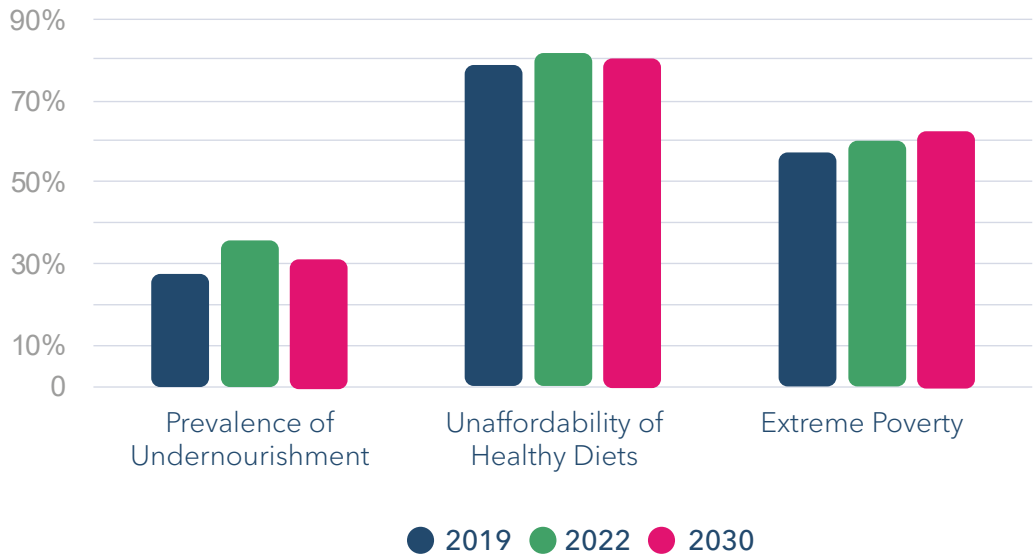


Note: Poverty is poverty headcount ratio at $2.15 per day (2017 PPP) (% of population), from World Bank, Poverty and Inequality Platform (nowcasts for 2013-2019) (WorldBank, 2023c). Undernourishment is the prevalence of undernourishment (percent) from FAOSTAT (FAO, 2023d).

The country has a young and increasingly urbanised population of approximately 20 million, with a median population age of 16.6 (UNDESA, 2022; WB, 2023b) as well as high unemployment with only 31% of the working age population employed (IMF, 2023). Given the country's flat growth that averaged 3.7% in the ten years preceding 2021, Zambia will not be able to lift its young and growing population out of poverty by 2030 (IMF, 2023). It will also not be able to improve food security and the quality of Zambians' diets (see Figure 2). Between 2022 and 2030, it is estimated that the population will increase by 24%, GDP by 50%, food prices (real terms) by 3% and the cost of a healthy diet by 7%.

Without additional investment, there will be virtually no improvement in Zambia's hunger, poverty and affordability of healthy diets by 2030

Figure 2. Trends in undernourishment, unaffordability of healthy diets and extreme poverty in Zambia



Sources: Poverty is poverty headcount ratio at USD 2.15 per day (217 PPP) (% of population), from World Bank, Poverty and Inequality Platform (nowcasts for 2013-2019) (World Bank, 2023c). Undernourishment is the prevalence of undernourishment (percent) from FAOSTAT (FAO, 2023d). Healthy Diets is the percentage of the population unable to afford a healthy diet (percent) (FAO, 2023a).

1.2 Low productivity and climate change

Zambia has an abundance of arable land and around 40% of the available water resources in the Southern African Development Community (SADC) region. Yet only 14% of its 45 million hectares of arable land is under cultivation and only 6% is under irrigation. The bulk of the land is farmed by approximately 1.5 million small-scale farmers (WFP, 2022),

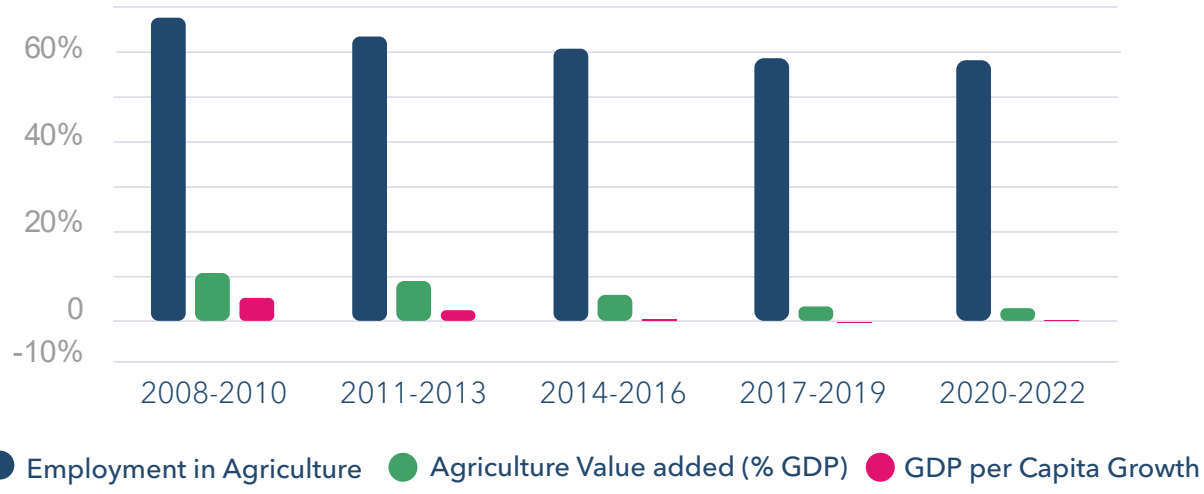
of which 62% are women (ILO, 2022). These farmers produce 80% of the domestic food supply (WFP, 2022) using traditional farming practices such as hand hoes and oxen with minimal purchased inputs, such as fertilizers (Branca et al., 2016). Zambia also suffers from endemic invasions of the fall armyworm, Spodoptera frugiperda, that affects at least 98% of small-scale farmers every cropping cycle, negatively impacting food security and livelihoods and leading to extensive economic losses. Women are the most affected as they often have less access to extension services (CABI, 2023). Livestock productivity is also low with smallholder-owned cattle often affected by diseases and inadequate nutrition (FAO, 2023e).

Agriculture is labour intensive but with low productivity, contributing only 3.4% to GDP in 2021, a decline from 9.3% in 2012 (see Figure 3) (IMF, 2023). This tracks annual GDP growth indicating the dependency of the Zambian economy on agriculture (RZ, 2022b). Nonetheless, commercial agriculture contributes significantly to the country's export earnings, accounting for approximately 29% of non-traditional exports and 7% of total national exports (African Union, 2023).

Critically, high food losses of between 30 and 40% in Zambia reduce potential surplus for on selling (UN, 2022). These are due to on farm losses relating to poor harvesting practices and inadequate storage facilities, as well as inefficient transportation and distribution systems that cause delays, spoilage, and losses along the supply chain.

Persistently high number of people employed in agriculture yet low value addition and non-existent GDP growth per capita

Figure 3. Agricultural trends in Zambia



Sources: GDP per Capita Growth is GDP per capita growth (annual %) from World Bank national accounts data, and OECD National Accounts data files. Employment in Agriculture is the Employment in agriculture (% of total employment) (modelled ILO estimate) from International Labour Organization "ILO modelled estimates database" ILOSTAT (Accessed January 2021). Agriculture Value added is the agriculture, forestry, and fishing, value added (% of GDP) from World Bank national accounts data, and OECD National Accounts data file.

Zambia's agriculture sector must mediate a highly variable and extreme climate. Endemic droughts occur every 4 to 5 years, and seasonal and flash floods, and extreme temperatures are occurring with increased frequency, intensity, and magnitude (FAO, 2023). At the time of compiling this report, Zambia once again is in the grip of a severe drought that destroyed close to half the country's crops. This leads to increased food insecurity and reduced growth, forecasted by the IMF to drop from 2.3% to 1.2% for 2024 (Hill & Mitimingi, 2024).

Since 1960, mean annual rainfall has decreased by an average of 1.9 mm per month (2.3%) per decade (SADRI, 2021). There is significant country variance, ranging from 600 mm in the lower southern areas to 1,300 mm in the upper northern regions predicted for the future (World Bank, 2023a).

The resulting losses are significant. Estimates suggest that drought related losses between 1982 and 2016 equate to USD 438 million and those of excessive rainfalls and floods to USD 172 million (SADRI, 2021). The severe drought of 2018/2019 affected 2.3 million people, who experienced increased food insecurity, and led to escalating food prices due to reduced agricultural output (Alfani et al., 2019). Livestock production in the grazing areas in the western and southern parts of the country were also affected, while low water levels in major rivers and groundwater systems increased water insecurity (SADRI, 2021).

Modelling for future climate conditions shows that the combination of reduced rainfall, increased temperature and drought events will lead to further crop loss, and a reduction in agricultural production, as well as negatively affect forest cover, livestock populations, and the length of the growing season (FAO et al., 2022). Climate related losses over the next 10 to 20 years are expected to amount to USD 2.2–3.1 billion (SADRI, 2021) with the Southern and Western regions projected to bear the most substantial negative impacts of climate change on crop yield and production (Ngoma et al., 2021).

Whilst Zambia's modernised commercial agriculture sector will be affected, rain-fed subsistence agriculture is particularly vulnerable (AfDB, 2018). By 2050, the production of heat- and drought-sensitive crops, such as maize, is expected to decline in all provinces – ranging from 20% in the Northwestern province, to 77–82% in the Copperbelt and Muchinga provinces. At the household level, the costs of reduced maize production are estimated to range from USD 1.50 to USD 28 per person, and up to USD 169 per household in the Southern province (FAO et al., 2022). The percentage of affected livestock is also predicted to rise from 39% (4 million livestock units) to 54% in the future. While livestock in the southern part of Zambia are most affected currently, the number of livestock affected by droughts could increase throughout the country in the future (SADRI, 2021).

Increasing the agriculture sector's resilience to systemic vulnerabilities, shocks, and stresses, is probably the most important challenge facing the country, and many of the interventions highlighted in the country's Food Transformation Pathways document - effective early warning system, climate smart agriculture, and efficient water management - focus on this aspect.

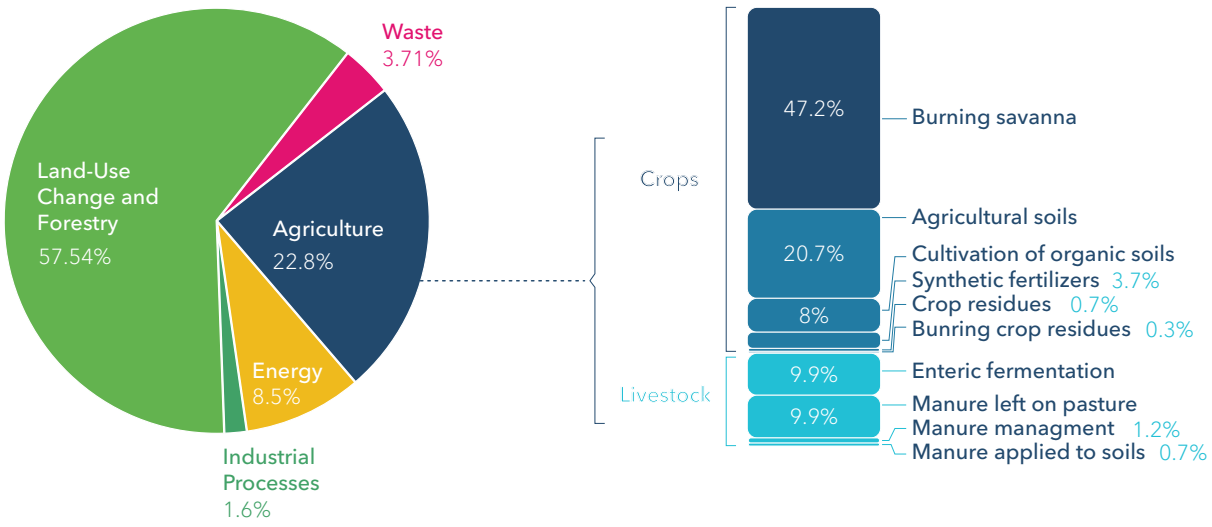
Yet simultaneously to being highly vulnerable to climate change, agriculture contributes significantly to the share of greenhouse gas (GHG) emissions. Droughts and low productivity drive deforestation and field burning as farmers clear land to sustain their incomes

(IMF, 2023). In 2021, Zambia's annual deforestation rate reached 300,000 hectares, among the highest globally, and a major GHG source after charcoal production (IMF, 2023). Unless addressed, land clearing will only increase in the future in light of projections that show that by 2050 more land will have to be cultivated to make up the shortfall in yields due to climate change (IMF, 2023).

In Zambia's agriculture sector, 59% of emissions come from savanna burning, including fire management and slash-and-burn practices, followed by enteric fermentation (13%), manure management (12%), organic soil cultivation (10%), and fertilizer use (5%). Between 2008 and 2018, agricultural GHG emissions rose by 31%, with livestock contributing 78% and rice 11% (World Bank, 2019).

Agricultural practices in Zambia are one of the most significant contributors to GHG emissions

Figure 4. Greenhouse gas emissions sources in Zambia (Mt CO2 eq)



Source: Climate Watch Historical GHG Emissions (1990-2020) (WRI, 2023) and World Bank, 2019

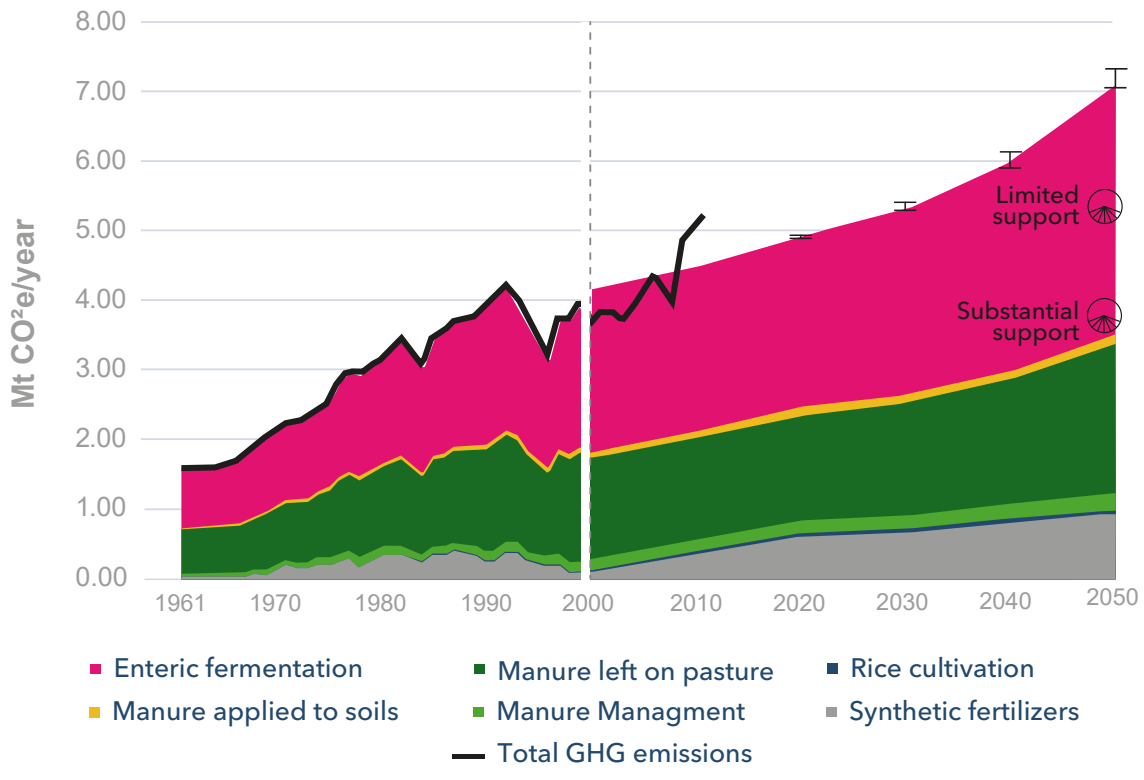
More generally, in 2020, Zambia's total emissions amounted to 91.2 million tons of CO2 which corresponds to 4.8 tons of CO2 per person, higher than the per capita emissions in sub-Saharan Africa which stands at 3.2 tons of CO2, but lower than the global average of 5.9 tons of CO2 per person. Agriculture and land use change are the two most important GHG emission sources in Zambia accounting for 24% and 61% respectively (Figure 4) (WRI, 2023). Without significant changes, emissions from agriculture and land use will fall short of Zambia's NDC goals (World Bank, 2019).

Zambia ratified the UNFCCC in 1993 and updated its NDC in July 2021, pledging a 25% GHG reduction (20,000 Gg CO2 eq.) by 2030 with limited external support, or 47% (38,000 Gg CO2 eq.) with substantial international aid, against a 2010 baseline. Targeted sectors include agriculture, forestry, and land use, with policies like the National Agriculture Policy and National Climate Change Policy promoting climate-friendly practices (RZ, 2021b; IMF, 2023).

Yet, agricultural GHG emissions in Zambia are projected to grow by 2.3% annually, or 25% in a decade, driven by rising food demand, particularly for animal products. Livestock emissions, especially from cattle will increase (Figure 5) and fertilizer use will contribute a larger share by 2050 under a business-as-usual scenario.

Contrary to NDC pledges, agricultural GHG emissions in Zambia are predicted to grow by 25% in the next decade

Figure 5. Trends in six sources of agricultural GHG emissions, 1961 to 2050, in a business-as-usual scenario



Source: Historical values are from FAOSTAT; the GLOBIOM model provides projections from 2000-2050 for scenarios without climate change.

Note: Limited and substantial support indicate NDC goals. Errors bars indicate the range in total emissions as a consequence of climate change.

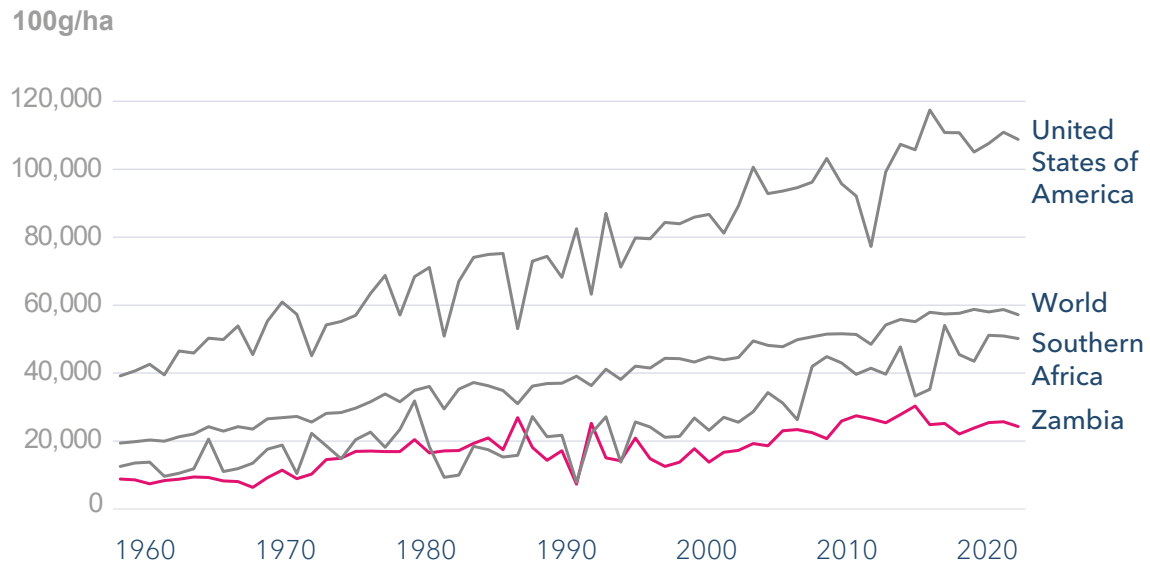
1.3 Maize-centric agriculture sector

Agriculture in Zambia is heavily concentrated on maize, the staple crop for 82% of smallholder farmers (Pinto et al., 2019). It is grown on 57% of the total cultivated land in Zambia and contributes 79% of total output of major food crops (FAO et al., 2022). Other crops include cassava, ground nuts, millet, sorghum, and sweet potatoes (FAO et al., 2022). Crop diversification is marginal despite evidence that it is critical to ensuring climate resilience and nutritional diversity, as well as contributing to improved livelihoods of smallscale farmers (Mwanamwenge & Harris, 2017). Responding to this challenge, the need to diversify is highlighted in policy documents such Zambia's Food System Transformation Pathways with crop diversification running like a golden thread across the different pathways (RZ, 2022a).

Despite its dominance, maize yields remain low (see Figure 6). Since 2000, Zambia's maize production has more than doubled, increasing by 140% because of both yield increases (+45%) and area increases (+6%). However, since 2011, yields have stagnated. In 2020, maize yields in Zambia were less than half the average for southern Africa and a fourth of the yield of the United States (one of the countries with the highest maize yields) (FAO, 2024).

Maize yields in Zambia are significantly lower than the averages in southern Africa and around the world

Figure 6. Average maize yields in Zambia, the United States of America, Southern Africa, and the world, 1960-2020



Source: FAO, 2024

Historically, Zambia's Farmer Input Support Programme (FISP) targeted mostly maize. Together with the Food Reserve Agency purchases, it accounted for 50% to 80% of annual public spending in the agriculture sector. This left little for other drivers of agricultural growth and the diversification of crops, livestock and fisheries, with research and extension services underfunded. Previous attempts to diversify the crops grown by small-scale farmers under the FISP by providing seeds for alternative crops such as millet, groundnuts and soya have had limited success (Box 1) (RZ, 2018; FAO et al., 2022; Phiri et al., 2020).

FISP has also been plagued by budget overruns, late delivery of inputs, standardized inputs that are not appropriate for all agro-ecological zones or soil types; crowding out of the private sector; poor targeting, and fertilizer inputs not reaching the intended beneficiaries (Fusani et al., 2016; SADRI, 2021). The incremental value of maize output produced by subsidised fertilizers is less than their costs in most years (Jayne et al, 2013). In addition, although there has been success in lifting households out of severe poverty, there is little evidence of a spillover effect to households not participating in the programme (Fusani et al., 2016; Mason et al., 2020).

Box 1: The case of maize: harmful subsidies and poor trade policy

The expansion of maize production in Zambia has largely been driven by government policy interventions that directly affect the level of demand, supply, and trade, rather than by market signals. Productivity gains in Zambia have not been the primary driver of expanding maize production, with land expansion, not yield improvements, being the main driver of increased output. A government policy subsidizing the cost of fertilizers led to increased use by farmers, with a resulting growth in yields. However, the benefits of this policy are relatively limited compared to the cost, due to important leakages (Zinnbauer & Mockshell, 2018).

However, Zambia's policy framework, which has, at times, involved trade restrictions and export bans, sends confusing signals. Trade restrictions are lifted and imposed sporadically. Domestic price regulations are also introduced frequently, while Zambia's Food Reserve Agency defines intervention prices on an annual basis. Policy interventions in each cropping season increase the risk associated with developing formal market operations, leading to limited business networks and infrastructure, and overall high and volatile trading costs. In this context, it is difficult for the Zambian maize sector to reduce costs to the level needed for it to become a stable actor on regional markets. Furthermore, taken together, these factors limit the extent to which external markets can stabilize the Zambian maize sector.

In addition to these interventions on the supply side (through fertilizer subsidies) and in trade (through export restrictions), the Zambian government also plays a significant role in creating volatility in demand because of its large public procurement programme. About 500,000 tonnes of maize are normally stored by the government every year, equivalent to a quarter of all production in the country. However, during the 2020/2021 year, the government announced that, due to the COVID-19 pandemic, it would procure 1 million tonnes of maize, or

a third of the harvest in this period (Esterhuizen, 2020). Domestic demand for maize is about 2.1 million tonnes a year.

These various forms of intervention collectively mean that the country's maize markets are highly distorted and strongly affected by public policies, which themselves may be inconsistent with one another: hectic price behaviour, including sharp price falls, has been among the consequences.

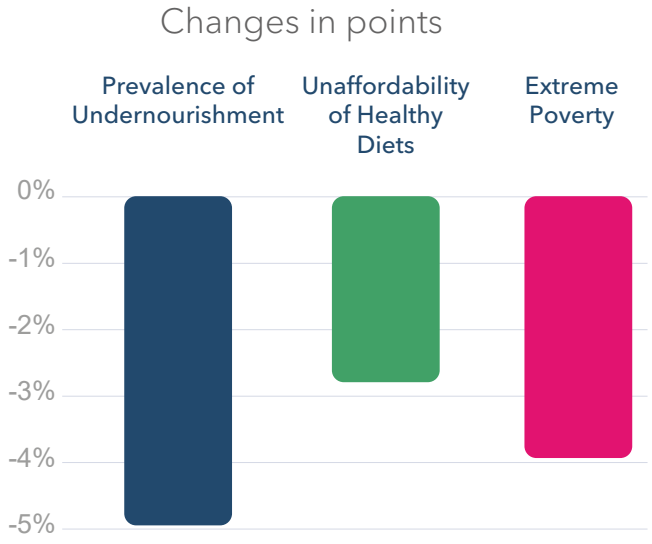
Despite the issues raised above, the Zambian government has expressed its ambition to develop production and exports of maize. The Comprehensive Agricultural Transformation Programme (CATSP) outlines targets to "double small-scale farmer yields from the current average of 2 Mt/Ha to 4 MT/Ha by 2027; to increase annual production from the current average of 3 million metric tons to 6 million metric tons by 2027" (RZ, 2022b).

The extent of Zambia's ambition, and the resources required to bring it to fruition, necessitates a better understanding of resources required, complementary policies and the economic, social and environmental trade-offs. The need to better understand the implications of an ambitious expansion of maize production was also repeatedly stressed by government officials during consultations (see Annex).

Achieving a doubling of maize yields by 2030 would cost an additional USD 1 to 1.5 billion in public investment, the salient outcomes of which are illustrated in Figure 7. On a positive note, it shows a potential 1.8% increase in GDP and a dramatic rise in yields, production and exports. However, critically, it indicates a decline in maize price, as well as a negative impact on key hunger and nutrition indicators, rising emissions and a reduction of cropland. Overall, the money would be better allocated to other priorities.

Doubling maize productivity would increase GDP, yields, and exports, however it will result in negative impacts on food security, nutrition, and rising emissions

Figure 7. Impact of doubling maize productivity in Zambia



Relative changes compare to baseline	
Real GDP	1.80%
Maize yield	67%
Maize production	66%
Maize exports	125%
Maize price	-29%
Poultry production	1%
Poultry exports	7%
Fruits & veg. production	+0.05%
Agrifood emissions	+4%
Cropland	-1.5%
Pasture	0.3%

The modelling of this scenario also indicates the need for a suite of complementary policies to regulate regional trade, and support and expand local value chains, such as poultry. This would both reduce downward pressures on maize prices by absorbing excess maize production as well as unlock new livelihood opportunities and better nutritional outcomes due to an increase in the availability and consumption of animal protein. In addition, and in response to the inadequate consumption of leafy green vegetables and fruit in Zambian's diets, maize incentives should be accompanied by incentives to diversify crops to address existing concerns relating to the maize centric diets of Zambians.

1.4 Poor and undiverse diets

Given the demographic and agricultural challenges faced by Zambia, it comes as no surprise that the country is not able to adequately feed its growing population. Whilst production of key food crops and meat has been increasing, keeping pace with population growth, domestic production of wheat, fruit and vegetables, fish, dairy, and edible oils have not kept up with consumption levels and are being met through imports (FAO et al., 2022).

Analysis of the Zambia Living Conditions Survey (LCMS) 2015[1] show that Zambians' diets lack diversity. Diets for both low- and high-income households remain dominated by starches and are lacking in vegetables, fruits, and animal-sourced foods. Specifically, diets are characterised by a high proportion of maize.

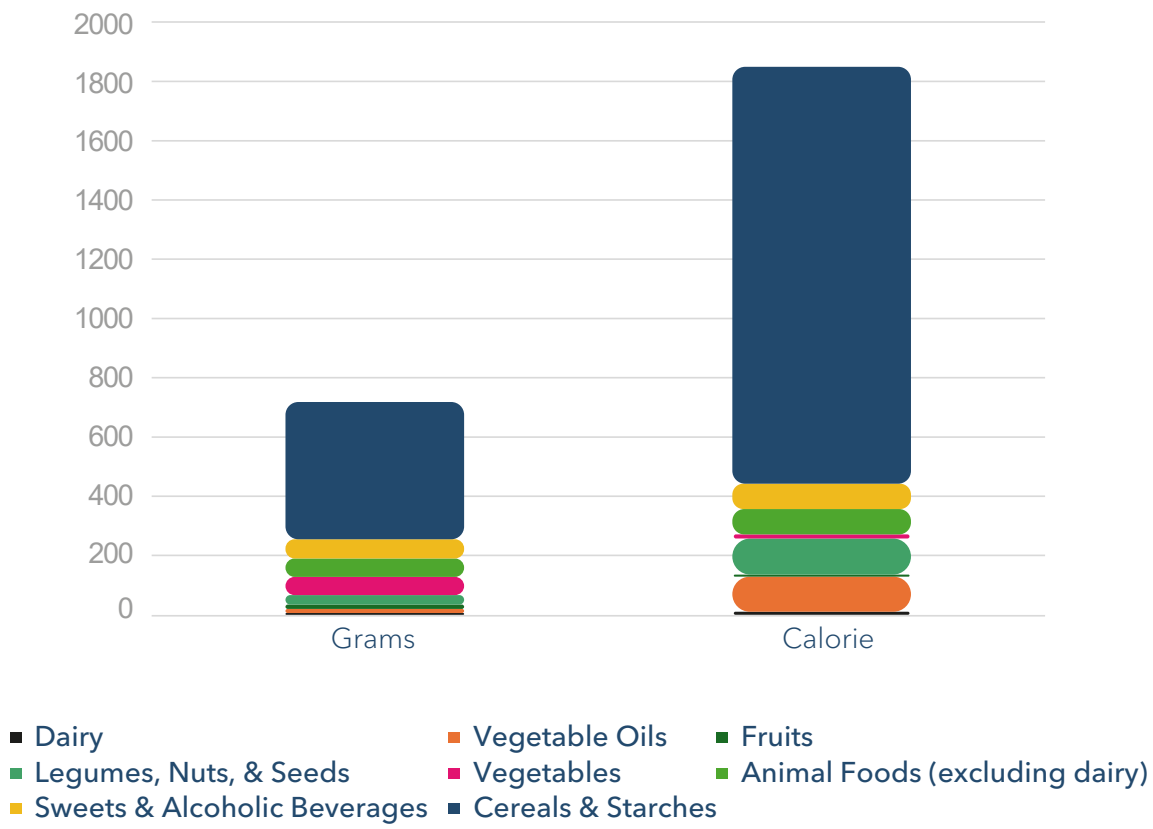
Zambia consumes the most maize per capita in the world. Its yearly maize consumption averaged 1.7 metric tons between 2019 to 2023 exacerbating malnutrition, particularly among women and children (AfDB, 2023b). Cereals and starches, largely maize, comprise 1408 out of the 1850 Kcal consumed on average in Zambia per day (Figure 8). This equates to 76% of the average daily caloric intake. In terms of quantity, 464 grams of cereals and starches are consumed daily, equal to 65% of daily food consumption. Much of the blame for the high levels of maize consumption can be attributed to the FISP which, whilst ensuring self-sufficiency in maize production and contributing to improving food security, has disincentivised the diversification of crops needed to address pervasive nutritional deficiencies in diets, especially in rural communities where access to well-equipped food markets is limited (Kuntusha & Mwlewa-Zgombo, 2022). Lending further impetus to the need to support farm level diversification is the strong linkages between production diversity and dietary diversity in the case of small-scale producers (Mulenga et al., 2021).

In terms of quantity, animal foods (excluding dairy), sweets and alcoholic beverages, and vegetables are the next largest food groups consumed, with around 60 to 65 grams of each being consumed daily. Combined, fruit and vegetables represent just over 10% of the average daily consumption in quantity terms but less than 1.2% of total caloric intake. Consumption of dairy items is significantly low – less than 1%. The poor level of diet quality is consistent with the low level of income, high prevalence of poverty, and unaffordability of healthy diets, as discussed in Section 1.

1 / Nationally representative household survey that contains data from 12,251 households, covering all 74 districts, and 95 distinct food items.

Diets in Zambia are largely dominated by cereals and starches

Figure 8. Overview of Zambian dietary composition, aggregated by food groups per capita per day



Source: Zambia Living Conditions Survey (LCMS), 2015. Nationally representative household survey that contains data from 12,251 households, covering all 74 districts, and 95 distinct food items.

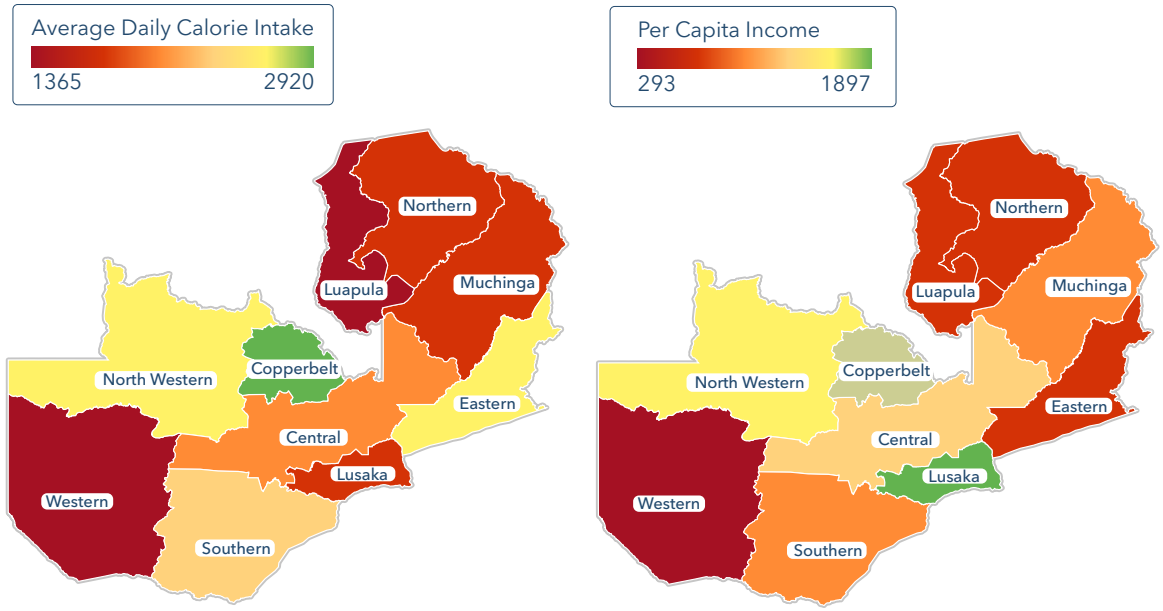
National averages hide important disparities across and within regions in Zambia, masking dietary differences and inequalities that will require targeted policy interventions. For example, amongst high-income, urban households there is an increased consumption of processed foods, and sweets and alcoholic beverages, such that Zambia is confronted with the complex challenge of the triple burden of malnutrition: a high prevalence of undernourishment, micronutrient deficiencies, and the growing issue of obesity.

Due to the different levels of income between provinces, consumption patterns vary significantly. Figure 9 shows the average calories consumed by each province alongside the per capita income of the province. Tracking their contribution to GDP, the Copperbelt region consumes by far the most calories in the country, as high as 2,900 Kcal per capita. People in the Eastern and North-Western provinces live on over 2,150 Kcal per day, high-

er than the average daily calorie intake of 1,850 per person. The remaining provinces are increasingly food insecure with caloric intake as low as 1,370 Kcal per capita in the Western and Luapula provinces.

There are important disparities across regions in Zambia, with people in the Copperbelt consuming many more calories than those in the Western and Luapula regions

Figure 9. Average daily caloric intake and income per capita, by province of Zambia



Source: Zambia Living Conditions Survey (LCMS), 2015.

The correlation between geographic location, GDP, and diets reflects the economic and demographic drivers of changing diets and a nutrition transition, such as urbanization and increasing access to supermarkets in Zambia (RZ, 2018). Increased urbanization is affecting diets with those in urban areas consuming a greater quantity and quality of foods compared to rural populations.

Overall, people in urban settings consume significantly more calories than rural consumers per day, 2053 Kcal versus 1703 Kcal a day. In both instances, cereals and starches make up the largest share of calories. However, urban dwellers eat more animal foods and less legumes, nuts, and seeds than rural households. Both groups eat little vegetables while rural households eat slightly more fruit. This might be explained by the consumption of wild fruit in rural areas (see Box 2) or the relatively cheaper prices of unhealthy food options in urban settings (as identified as one of the drivers of poor consumption patterns in Zambia's Food Systems Transformation Pathways: The Road to 2030 document). The other significant difference is the considerably higher consumption of vegetable oils by

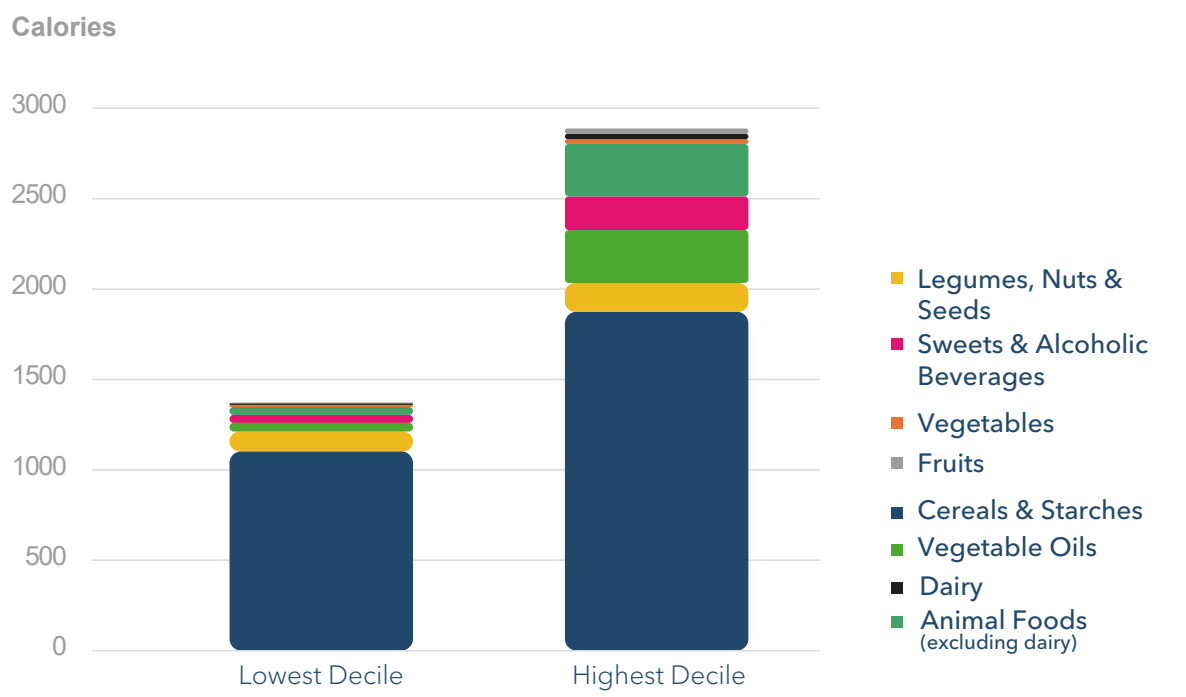
urban households as well as sweets and alcoholic beverages that underpins the rising rates of obesity and diabetes in Zambia.

Spending on fruits and vegetables, animal source foods, fats and sugars, and processed foods has increased, with these changes greater in urban than rural areas and even more advanced in high income households in urban areas. While this is consistent with rising incomes and rapid urbanization, it also reflects a rise in income inequality in both urban and rural parts of Zambia (Chisanga & Zulu-Mbata, 2018; Harris et al., 2019). Rising incomes have also contributed to a steep rise in beef production to meet the increase in demand (FAO et al., 2022).

Unsurprisingly, there are notable differences in diets between poor and more affluent households (Figure 10). Consumers with the highest income consume 2900 Kcal per day whereas those with the lowest income consume 1400 Kcal per day. While starch and cereals are still the dominant source of calories in the highest income group, it is at a much lower percentage at 65% compared to 80% in the lowest income group. There is a significantly greater consumption of vegetable oils, animal foods excluding dairy, and sweets and alcoholic beverages, reflecting the greater economic accessibility of such food groups.

The lowest-income households consume half the calories of highest-income households, with extremely low dietary diversity

Figure 10. Share of calories consumed by food category by consumers with the lowest and highest income in Zambia

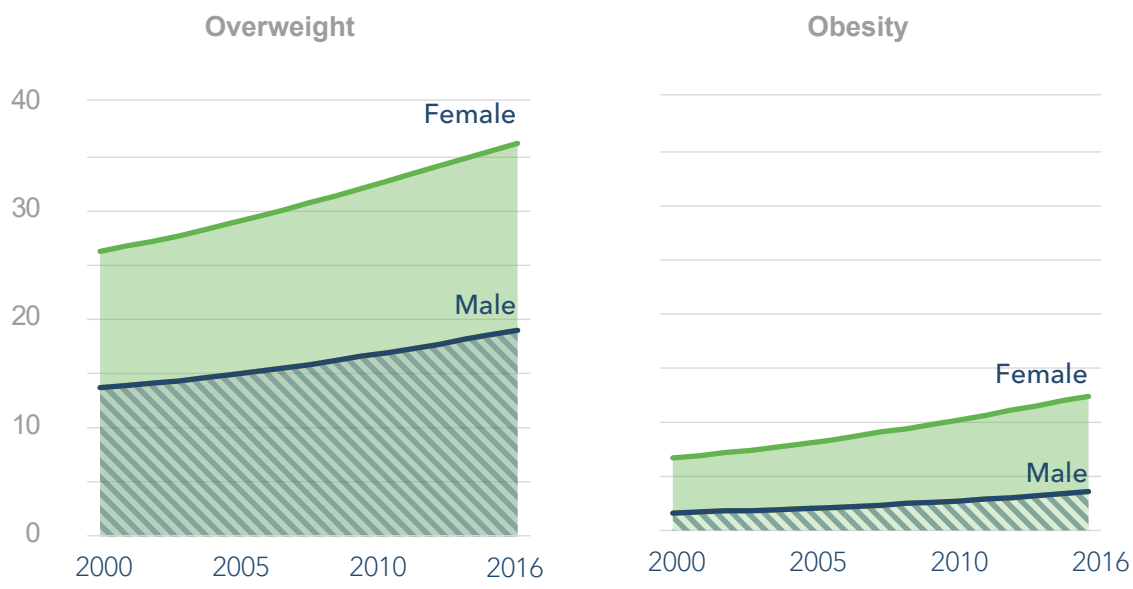


Source: Zambia Living Conditions Survey (LCMS), 2015.

Zambia is also confronted with the complex challenge of the triple burden of malnutrition: a high prevalence of undernourishment, micronutrient deficiencies, and the growing issue of overnutrition. Obesity rates nearly doubled from 5.7% in 2008 to 10.3% in 2022 (Figure 11), while rates of diabetes increased from 4.8% in 2011 to 11.9% in 2021. However, there is a strong gender dynamic to the prevalence of overweight and obesity in Zambia. As Figure 11 shows, the prevalence of obesity and overweight amongst women is significantly higher than men. In 2016, the most recent year for which there is gender disaggregated data, nearly twice as many women were overweight than men and over three times as many women were obese (Global Nutrition Report, 2022).

Overweight and obesity are on the rise, primarily among women

Figure 11: Overweight and obesity in Zambia by gender, 2000-2016

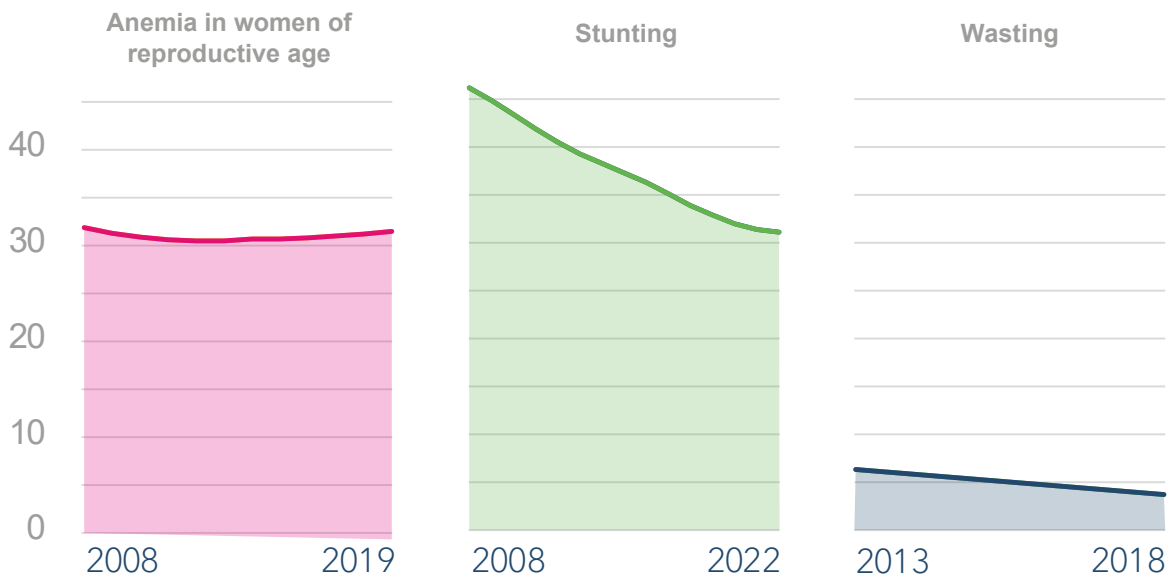


Source: Global Nutrition Report, 2024. Overweight (including obesity) as equal to or greater than 25kg/m2 (BMI≥25), and obesity as equal to or greater than 30kg/m2 (BMI≥30).

With regards to childhood nutrition, the overall trends of the nutritional status of children under 5 years have been improving. The prevalence of stunting amongst children decreased to 31.4% in 2022, a significant decrease since 2008. The rates of wasting (acute malnutrition) have similarly decreased from 6% in 1992 to 4.2% in 2018 (Figure 12) (World Bank, 2023b). Finally, anaemia continues to affect one in three women of reproductive age (World Bank, 2023b).

Stunting has significantly declined, alongside the decline in hunger

Figure 12. Nutrition indicators in selected population groups in Zambia, 2008-2022



Source: Anemia is the prevalence of anaemia among women of reproductive age (15-49 years) (percent), from World Health Organization, Global Health Observatory Data Repository/World Health Statistics (World Bank 2023b). Stunting is the percentage of children under 5 years of age who are stunted (percent), UNICEF, WHO, World Bank: Joint child malnutrition estimates (JME). Wasting is the percentage of children under 5 years affected by wasting (percent), UNICEF, WHO, World Bank: Joint child malnutrition estimates (JME) (World Bank 2023b).

Overall, whilst there has been progress in reducing the prevalence of hunger and malnutrition over the last decade, these improvements have not been rapid enough for Zambia to be able to meet its targets to achieve SDG 2 on ending hunger and all forms of malnutrition by 2030. Similarly, the African Union has indicated that Zambia is not on track towards achieving the food security and nutrition targets and commitment of the Malabo Declaration by 2025 (African Union, 2020).

Box 2: Coping strategies of low-income households

Many low-income households rely on kapenta, an affordable small fish, rich in protein, B12, calcium, iron, and zinc (Biesalski, 2012; Marinda et al., 2018). Sometimes these fish species are used to fortify maize based weaning foods for infants to provide micronutrients that are often lacking in their diet because of the overall low consumption of animal protein (Owino et al., 2008; Haug et al., 2010).

In Zambia, insects such as caterpillars, grasshoppers, winged termites as well as winged ants are an important source of protein in the diets of low-income households, eaten in times of scarcity but also included in diets throughout the year or when seasonally available. Insects are a source of protein, fat and other nutrients found in other animal proteins and their consumption contributes significantly to the recommended daily requirements of iron, zinc, calcium, and potassium, as well as the essential amino acids important for human growth (Mwambungu, 2014). Insects are also included as an important source of protein in the Zambian Food Based Diet Guidelines (Ministry of Agriculture, 2021).

Lastly, edible wild fruit and nuts are an important part of rural diets, providing cheap and easy sources of food (Moombe et al., 2009), and vital during periods of food scarcity, when their consumption can reduce food insecurity by about a third (Moombe et al., 2009).

Chapter 2:
EFFECTIVE INTERVENTIONS TO OPERATIONALIZE ZAMBIA'S PATHWAYS

2.1 Prioritizing sustainable food system transformation

Zambia and its development partners should prioritize a portfolio of interventions to diversify production, increase the consumption of safe and nutritious foods, reduce food waste and loss along value chains, and improve access to tenure rights and finance. Moreover, while focusing on the need to increase the availability and affordability of diverse and nutritious foods, the country should also consider the critical need for Zambia to become more resilient to climate change stresses and shocks, as well as the need to contain GHG emissions from agriculture and land use change. This will require investment in stronger early warning systems and social protection programmes, such as seasonal and weather-based cash transfers.

2.2 Zambia's food system transformation pathways

Zambia's Food Systems Transformation Pathways: The Road to 2030 (Pathways document) emerged from the United Nations Food Systems Summit in 2021 and in support of the 2030 Agenda. The Pathways document is the outcome of extensive stakeholder engagements on the transformation of the existing food system towards zero hunger and food security and nutrition by 2030. There are five pathways linked to 54 priority actions. The five pathways are:

1. Ensuring access to safe and nutritious food for all
2. Shifting to healthy and sustainable consumption patterns
3. Boosting nature positive food production
4. Advancing equitable livelihoods of people involved in the food system; and
5. Building resilience to vulnerabilities, shocks and stresses.

Whilst there is much overlap between the five pathways reflecting the systemic nature of the problems, there are important differences in emphasis.

Pathway 1 focuses on access to **safe and nutritious food for all,** acknowledging the need to create awareness about safe and nutritious foods, the lack of knowledge relating to sustainable food production methods, and the pressing need to shift agriculture from

predominantly maize centric and rainfed in order to address malnutrition and non-communicable diseases. It is relevant to SDG 1, SDG 2, SDG 3 and SDG 10.

Pathway 2 focuses on **shifting to healthy and sustainable consumption patterns**, acknowledging the present challenges relating to the unaffordability of healthy diets exacerbated by urbanisation and lifestyle choices. Interventions under this pathway are clustered around supporting the consumption of healthy food and ensuring food safety by investing in better storage, regulating the selling and labelling of food, biofortification and food fortification, improvement of school meals, and social behaviour change communication. A key intervention under this pathway is the implementation of the Food-Based Dietary Guidelines.

Pathway 3 focuses on **boosting nature positive food production**. It aims to integrate climate responsive farming systems and the more efficient utilization of resources. This is a response to the present food production systems that are unsustainable, characterized by high food loss and waste, have an underdeveloped livestock and fishery sector, low crop and livestock diversity, high prevalence and susceptibility to diseases, inadequate extension services, and offer farmers limited access to affordable financial services. This pathway seeks to integrate SDG 1, 2 and 3 while utilizing resources more efficiently and sustainably targeting SDG 12, 13, 14 and 15.

Pathway 4 focuses on **advancing equitable livelihoods of people involved in the food system** and seeks to address the inequality of access to land and economic resources by unlocking equitable livelihoods to marginalised groups and ensuring that no one is left behind.

Pathway 5 focuses on **building resilience to vulnerabilities, shocks and stresses**, acknowledging the increasing threat of climate change and aiming to improve the resilience of vulnerable communities through improving early warning systems, climate smart agriculture, and other adaptation strategies.

Each Pathway offers a set of priority action tracks and targets linked to the SDGs, the executing institutions, and key stakeholders as well as timelines for implementation – short term, 2022-2024, or long term, 2022-2030.

Whilst Zambia has made progress with the restructuring of its sovereign debt, the country will remain fiscally constrained for the near future. The Pathways document identifies 10 priorities and actions that consider the current fiscal reality as well as the systemic interlinkages between the five pathways.

Priority #1

Increase crop diversification through climate-smart agriculture

Given the urgency to address the existing dominance of maize in both production and consumption, and the recurring impact of drought on rainfed maize crops, **crop diversification** is critical to improve availability of food, quality of diets, and resilience to shocks. Households that practice crop diversification show significant increases in production of calories and protein, improving both diversity and quality of diets, as well as improved crop sales, while at the same time contributing to sustainable intensification (Sauer et

al., 2018; Mhlanga et al., 2021). While crop diversification is highlighted as a cross-cutting intervention to address nutrition, improve incomes and increase resilience to climate change (Pathways 1. 2, 3.2, 1.4, 3.6, 5.1), shifting existing entrenched crop production patterns will require a review and revision of the existing focus on maize. Currently, maize is prioritized with large input and output subsidies taking up a sizable portion of the agriculture budget (Chapoto et al., 2016). This should be prioritized and actioned under Pathway 3, Action 10 which provides for the redesign of the Farmer Inputs Support Programme (FISP) to create a policy to subsidise inputs for nature-positive production (see Box 1).

Interventions promoting the use of **climate smart agriculture (CSA)** practices and technologies in the diversification and expansion of crops, livestock, and fisheries, are critical and can be found across Pathways 3 and 5 (Pathways 3.1, 3.3, 3.4, 5.1, 5.2, 5.3, 5.4). According to the World Bank (2019), there is significant potential in Zambia for the scaling up of CSA such as reducing postharvest losses, conservation agriculture, agroforestry, minimum soil disturbance and residue retention. For maize, strategies to reduce post-harvest loss are the most effective intervention, able to boost production per hectare by 23% from 3.9 MT/ha to 4.8 MT/ha, which approaches Zambia's Vision 2030 target of 4.9 MT/ha (RZ, 2016). Compared to conventional practices, conservation agriculture could increase maize yields by around 14%; agroforestry (12%); minimum soil disturbance (9%); and residue retention (4%). For cotton, groundnuts, and soybeans, minimum soil disturbance offers the largest positive impact. The benefits of CSA are also expected to be more pronounced under climate change projections. With respect to food availability, conventional agricultural practices are on track to meet the lower limit of national caloric requirements by 2050. With CSA, food availability is expected to increase still further, even under climate change (World Bank, 2019).

However, climate smart agriculture implementation has floundered in Zambia in the past due to inadequate funding for such projects, lack of access to markets, and capacity building (IMF, 2023). To work effectively, public funds will need to be allocated to create incentives that attract funds from the private sector and development partners. These funds, from international and local institutions, can be used to mainstream and plan for CSA to ensure that trade-offs are minimised and synergies between productivity and resilience are realised (IMF, 2023).

In this regard, it is a positive development that donor funded projects such as the Sustainable Intensification of Smallholder Farming Systems in Zambia (SIFAZ), funded by the EU and the BENGO III - Conservation of Natural Resources and Food Security through Strengthening and Consolidation of Sustainable Agriculture in the KAZA area, funded by GIZ, are supporting crop diversification and climate smart agriculture (CIMMYT, n.d). Another potentially impactful project is Zambia's Integrated Forest Landscape Project (ZIFLP) that incentivises farmers to switch to climate smart agriculture through capacity building, but also generates an income stream for participating farmers in the longer term through payments for carbon saved (Biocarbon, 2023).

Box 3: Donor-funded projects in Zambia

Analysis of existing donor funded projects identified 27 projects that contribute to the transformation of food systems in Zambia. These are financed by a wide range of institutions, including the World Bank, ADB, USAID, EU, IFAD, GIZ/BMZ, JICA, SIDA and FCDO, and spread across Zambia's ten provinces. Fourteen of the identified projects address the food security, nutrition and climate change nexus, 3 projects address the nexus between food security and climate change, and 10 projects address the food security and nutrition nexus.

Most of the initiatives centred around the nexus of food security, climate change, and nutrition are situated in Zambia's agrarian regions, particularly in provinces such as Eastern, Luapula, Central, and Southern. Conversely, the provinces with the least concentration of projects focusing on the nexus are in Western, Northwestern, and Muchinga provinces.

The emphasis on **traditional crops**, such as sorghum, millets, cassava, and legumes, such as cowpeas and Bambara nuts, to strengthen the food system's resilience against climate change is welcome but should be treated with caution (Pathways 1.2, 2.10, 3.6, and 3.7). The uptake of traditional crops will require Zambia to review the existing FISP to ensure the inclusion of traditional crops in the subsidized basket of seeds provided to farmers. Anecdotal evidence suggests that the inclusion or exclusion of a crop from farmer support programmes in Zambia has a linear connection to the production of that specific crop, with the production of millet falling by 33% between 2020/2021 and 2021/2022 after it was excluded from the FISP (Akinola et al., 2020; Kalunga, 2023). Incentivising production and consumption of indigenous and traditional crops (Pathway 3) is an important measure to counteract negative perceptions of these crops as inferior.

Whilst traditional crops such as millet and cassava, for example, are more drought resistant than crops such as maize and rice, the need to prioritize **drought resistant** seeds as an overarching strategy to respond to future climate impacts is not specifically mentioned in the Pathway document. The introduction and availability of such seeds cannot be overstated. Studies on the application of drought-resistant seeds, including maize, have demonstrated significant increases in yields and reduction in drought related risk, resulting in improved food security and livelihoods (Acevedo et al., 2020; Innovation Commission, 2023b). In the case of maize, a study by the World Bank (2019) estimated that a full replacement of improved maize seeds with drought-tolerant maize seeds would pull an estimated 360,000 Zambian households out of poverty.

Given Zambia's predominantly rain-fed crops, funding allocated toward expanding agricultural research on nature-positive production (Pathway 3.7) should prioritize assessing the applicability and adoption of drought-resistant seeds. Imperfect information - due to a lack of information, poor information, or ineffective knowledge sharing pathways - can severely limit or slow the adoption of seeds and the diffusion process. Therefore, intensified awareness and efforts on seed availability, favourable climatic and agronomic requirements, performance characteristics and other special attributes are essential for the effective adoption of any seed-based technology (Amondo et al., 2019; Innovation

Commission, 2023b). Furthermore, the availability and effectiveness of extension services and outreach, as well as the education levels of heads of households, farmers' access to inputs, especially seeds and fertilizers, and the socio-economic status of farming families are very important to support adoption (Acevedo et al., 2020).

Priority #2

Expand sustainable livestock and aquaculture production through climate-smart agricultural practices and technologies

Sustainable livestock and aquaculture production play a crucial role in dietary diversification by providing a rich source of protein, essential nutrients, and omega-3 fatty acids, contributing to a well-rounded and balanced diet. A controlled study of 300 households in the Copperbelt Province of Zambia indicated that smallholder livestock ownership has the potential to enhance food security by raising incomes of the poor and by increasing the availability of nutrient-dense foods, both of participating households and the local food economy (Jodlowski et al., 2016). Analysis of survey data of 400 households from four Southern districts also found strong linkages between livestock income and household food and nutrition security (Nkomoki et al., 2019). These findings strongly suggest that policies supporting livestock development programmes such as training in animal husbandry should be prioritized (Nkomoki et al., 2019).

Acknowledging this, the Pathway document emphasises the need for resilient livestock production (Pathways 3.3, 3,15, 5.3). Interventions to improve existing practices are already underway. Examples include the enhancement of disease surveillance and response systems through the establishment of regional veterinary laboratories, the community-based livestock breeding programme that uses a pass-on scheme to support livestock farmers with high quality breeding stock, and interventions to address degraded rangelands to build climate resilience and improve the availability of pasture and fodder (RZ, 2023a). To date, 225,000 livestock have been distributed to 36,000 households countrywide. In 2024, a total of 12,000 livestock farmers will benefit under this programme (RZ, 2023a).

However, the need for increased consumption of animal-source protein to ensure sufficient micronutrient uptake, particularly by children, is not singled out as a key action under Pathway 1 but covered in the Food-Based Dietary Guidelines. In line with this, Pathway 1.4 makes provision for the diversification of agriculture, livestock, and fisheries in line with the Guidelines.

Critically, the need to address the increased GHG emissions, as well as the potential GHG emission implications from the choice of which livestock to expand, is critical and inadequately addressed in the Pathways document. Increased GHG emissions is also not addressed in the National Climate Change Response Strategy (RZ, 2010) or National Policy of Climate Change (RZ, 2016a), both of which are strongly focused on adaptation measures and do not place significant emphasis on emissions from the livestock sector. Given that the Comprehensive Agriculture Transformation Support Programme (CATSP) makes provision for the significant expansion of livestock, including cattle, small ruminants, poultry and aquaculture (RZ, 2022b), Zambia is strongly advised to include measures in the Pathway document to address the increased emissions and to ensure that the country does not overshoot its NDC commitments (RZ, 2021b).

Given the prominent role of fish and fish related products in the diets of Zambians, the significant contribution of micronutrients to their diets, and the potential of fish meal to address stunting in children, it is suggested that the actions in the Pathway document targeting sustainable fisheries and the expansion of sustainable aquaculture should be prioritized (Pathways 3.1, 3.3, 3.5, P3.6, 3.16 and P3.1). Actions that should be taken include the stabilising of natural stock by enforcing sustainable fishing practices and supporting the production of small nutrient fish such as kapenta by incentivising small and medium sized aquaculture farmers (Nölle et al., 2020). In this regard, interventions can build on existing donor initiatives such as the EU funded Zambia Sustainable Small-Scale Fisheries Programme (ZSSFP) executed by GIZ in the Luapula district (Chipili et al., 2022; GIZ, n.d.a). Supporting the expansion of sustainable aquaculture is also closely aligned with the strong national targets for 2024 aimed at the establishment of more fish hatcheries and increasing fingerling production from 302 million to 433.4 million, with the broader objective of addressing the country's current national fish deficit from the current level of 74,000 tonnes to 52,000 metric tonnes (RZ, 2023a).

Priority #3

Extension services to support adoption of climate-smart agriculture for crops, livestock and aquaculture production

Acknowledging the requirement for awareness raising and capacity building, the Pathway document recognises the crucial need to bolster support for **extension services**. These play a pivotal role in facilitating the effective diversification of crops among small-scale farmers and promoting the adoption of climate-smart agriculture practices, including mixed livestock production and aquaculture (Pathways 1.13, 1.4, 3.12, 3.13, 3.14 and 5.3). Given the acknowledged lack of capacity and resources, this support, however, should be directed towards innovative solutions, notably the incorporation of Information and Communication Technologies (ICTs) to enhance extension services and concurrently reduce the per-farmer cost of these services. Digital extension services can cost-effectively influence farmers' decisions and inexpensively provide timely, science-based, and potentially customized information to farmers on topics such as weather forecasts, pest outbreaks and control, new seeds or other agricultural technologies, and soil chemistry (Innovation Commission, 2023a). They also offer tremendous potential for scale. Zambia can leverage what has been done by other countries, such as Ethiopia and Kenya, to develop new digital advisory systems or improve existing ones (Innovation Commission, 2023a). Moreover, Zambia can potentially digitally disseminate agricultural information at a low-cost and massive scale using social media platforms (as proposed under Pathway 3.12).

Zambia-specific insights can be gleaned from successful models such as the Community Markets for Conservation (COMACO). This organization has demonstrated the efficacy of utilizing radio programmes to provide extension services to more than 250,000 farmers across Eastern, Central, and Muchinga provinces in Zambia, showcasing the benefits of leveraging technology for impact in agricultural development (COMACO, n.d.). In this regard, as expressed in the Pathway document, the Zambian government sees a critical role for cooperation partners to assist in implementing smart agricultural technologies including conservation agriculture, water harvesting, adaptive research, on-farm research programmes, agricultural insurance, as well as early warning systems (RZ, 2023a).

To ensure an inclusive process, it is important to provide for a specific **gender focus** in all outreach and capacity building programmes. A good example of this is the Food Enterprises for a Developed Zambia (FED Zambia) programme, funded by SIDA. This programme requires that at least half of the businesses receiving customized technical assistance are owned by women, half of the attendees to receive sector-wide training are women, and that women should receive an equal share of the in-kind grants (Technoserve, 2022). Also funded by SIDA is the Increasing Climate Resilience in Energy and Agricultural Systems and Entrepreneurship (INCRESE) Programme that includes targets for women's participation (SIDA, 2023).

An analysis of 11 agriculture development projects with empowerment objectives and a scoping review of livestock interventions identified the following best practices that should inform programmes aimed at empowering women. First, they should be appropriate for their culture and context, build on baseline data, and learn from other projects in the region. Second, they should be cognisant that group-based approaches whilst effective may exclude the most vulnerable due to group dynamics or existing work burdens. And third, both men and women should be included in institutional structures. Findings from the review suggest that cooperatives and groups (e.g., supporting the formation of dairy cooperatives or brooder groups) in livestock interventions have the most positive impact on women's empowerment. This is followed by extension support such as advice on forage, training, education, and productivity enhancing interventions focussed on new feed varieties or breeds (Quisumbing et al., 2023).

Priority #4

Early warning systems

Better weather-based forecasts are becoming increasingly important in the context of growing climate-related weather variability and intensity. The Zambia Drought Management System (ZADMS) portal has already been developed, which, amongst other services, provides portals on weather forecasts, a drought management tool, a news feed, and an online bulletin. However, most data used in the tools are based on satellite data and are dependent on the availability of other data providing platforms such as Google Earth Engine, NOAA, or NASA which may lead to delays.

Zambia should prioritise enhancing the existing early warning system capabilities by making data more geographically specific, addressing time lags, and making the information even more freely available. Lowering the costs of digital solutions will help small-scale farmers and SMEs access extension services, enter markets, be informed on prices, negotiate fairer prices, organise logistics, reduce food waste, prepare for economic shocks and extreme weather, and much more.

Priority #5

Expand water infrastructure, including irrigation, rainwater-harvesting and dams

Given its dependence on rain-fed crops, it is critical that Zambia invest in water infrastructure that can protect farmers against recurring droughts (Pathways 1.11 and 3.17), which,

at the time of writing, has led to the declaration of a national disaster. In this regard, increased investment in low-cost harvesting infrastructure, dam constructions and rehabilitation, and irrigation technology popularization under Pathway 3.17 should be a priority.

Zambia can draw from best practices elsewhere that do not require specialised equipment and can be implemented post-harvest when the opportunity costs of family labour and wages for paid labour are low. These include training on-farm rainwater-harvesting techniques such as mini-catchments that can increase yields, reverse soil degradation, and combat desertification (Innovation Commission, 2023a). For example, the adoption of demi-lunes in Niger increased agricultural revenue by USD 40 per year and improved soil quality and land usage over multiple years. Likewise, in Malawi, the adoption of similar pit planting techniques also increased yields by 19% (Innovation Commission, 2023a).

Lessons can also be learnt from existing and recent projects such as the Accelerate Water and Agricultural Resources Efficiency (AWARE) programme, supported by the EU and GIZ, which aimed to enhance sustainable and efficient agricultural water resource management for smallholders in the Lower Kafue Sub-Catchment through both demonstration sites and farmer training (EU & GIZ, 2019).

Priority #6

Incentivise private investment through access to finance and secure tenure rights, particularly for women

The Pathway document aims to improve the capacity of small-scale farmers to be more financially literate, develop business skills, and improve their access to finance and insurance (Pathways 1.5, 1.6, 4.3, and 4.4). Zambia is already responding to the need to address poor access and literacy with the introduction of the Sustainable Finance Facility aimed at small-scale farmers, emergent farmers, and public service workers who are not beneficiaries of the Farmer Input Support Programme (FISP) and the Food Security Pack (FSP). With this facility, farmers will be able to access credit under an agriculture credit window that will provide them with affordable financing to procure inputs, equipment, and irrigation systems (RZ, 2023b; RZ, 2023c). The importance of improved access to finance is the focus of quite a few donor projects, such as the Luangwa Livelihood and Conservation project of USAid (see Box 3) (USAid, n.d.b).

Zambia is also leading on innovative practices such as seasonal loans during the pre-harvest hungry season and post-harvest. These loans reduced the need to undertake paid hourly work on other farms by 25%, facilitating on-farm labour investment which increased the use of paid labour by 67% and increased family labour by 11%. The result was a 9% increase in agricultural output and improvements in food security with larger effects observed for poorer households facing the highest seasonal liquidity constraints (Innovation Commission, 2023b).

However, women's rights and land tenure, especially for widows, have a considerable influence on the extent to which small-scale farmers can access finance and invest in innovative technologies. Investment in land is highest when the widow inherits from her deceased husband, lower when someone in her family inherits, and lowest when the land reverts to the chief or to a family member not directly related to the widow. For example,

research has found that in villages where the widow does not inherit the land, households tend to use 13–18% less fertilizer, fallow 4–5% less land, and employ intensive tillage techniques on 3–5% fewer hectares, relative to the averages among other households (Dillion & Voena, 2018).

The economic impact of this is significant. Pathway 4.2 makes provision for the review and development of (existing) policies to advance equitable livelihoods for vulnerable and marginalised groups, including women. Given the evidence, an impactful intervention that should be prioritized is the introduction of a national policy to protect the land and property rights of women, and to review and repeal all discriminatory laws that currently exist. This should be accompanied by measures to improve the judicial sector's capacity to effectively interpret and apply national law that protects and promotes women's property, as well as education and awareness campaigns to create and sustain a positive environment that supports women's tenure rights and helps to transform public perceptions and institutional norms regarding women's property entitlement (ICRW, 2004).

Weak tenure rights also negatively affect the adoption of sustainable agriculture practices. Compared to households with statutory tenure rights, households with customary land tenure had a 17.4%, 17.2%, and 9.1% lower probability to adopt crop diversification, agroforestry, and planting basins, respectively (Nkomoki et al., 2018). This has implications for the food security of these households as the implementation of crop diversification and agroforestry has been associated with the food security status of smallholder households (Nkomoki et al., 2018). Moreover, a lack of title also limits the use of the land as collateral for finance. In this context, it is strongly recommended to prioritize Pathway 4.1: review of land tenure and provision of fair access to enable a robust sustainable food system transformation.

Priority #7

Access to markets, integration into value chains, energy infrastructure, and reduction of post-harvest losses

Access to markets and integration into value chains are critical to improve livelihoods, diets, and nutrition. An analysis of 6,000 small-scale farmers in Zambia indicated that market participation enhances household dietary diversity and improves household nutrition (Mulenga et al, 2021).

The need to roll-out **agro-processing and storage facilities** to mitigate post-harvest losses is covered extensively in the pathways with a strong focus on investing in agro-processing, cold storage, and small-scale agro-processing (1.11, 3.17, 1.3, 1.7, 1.8, 1.9, 1.11, 1.17 and 2.3). It is also a strong focus in other policies such as the National Agriculture Policy 2012-2030 (NAP) (RZ, 2011) and the CATSP (RZ, 2022b). It is critical to ensure that these are appropriate and cost effective. For example, small-scale storage solutions, such as silos, can contribute to safeguarding grains.

The aquaculture sector provides a good snapshot of the current value chain challenges in the country. A study conducted in the Siavonga district, Southern Zambia showed that both fishers and aquaculture producers suffered losses due to the lack of cold storage facilities to preserve fish and the poor road network that makes it difficult for aquacul-

ture producers to get their produce to market (Maulu et al., 2020; Nölle et al., 2020). These losses are particularly regrettable given that Zambia is a net importer of fish to meet growing demand (FAO et al., 2022). Existing donor projects that aim to address some of these challenges include the Green Innovation Centres for the Agriculture and Food Sector, a multi-focus project aimed at capacity building, the development of value chains and processing enterprises, and access to financing, markets, seed, fertiliser, pest management and agricultural machinery (GIZ, n.d.b). A similar project, Food Enterprises for a Developed Zambia (FED Zambia) programme, funded by SIDA, is also underway in the Copper Belt (Technoserve, 2022).

Missing from the Pathways document, but essential to all the pathways, is improved access to energy. Zambia has a low overall electricity rate at 42%, which is highly skewed in favour of urban households who have 75% electrification, compared to rural households with only 12% access (IRENA & FAO, 2021). These low rates of electrification are driving the clearing of forested land for agriculture to respond to the rising demand for wood fuels for cooking and heating, particularly charcoal in urban areas (Richardson et al., 2021). Accordingly, addressing deforestation going forward will depend less on changes in land practices than addressing energy poverty, either through increased electrification or, in the case of rural and more isolated areas, employing renewable energy technologies.

There is also an untapped opportunity for increased investment in off-grid solar technologies to address existing elevated levels of food loss and waste. Agro-processing systems based on renewables, either stand-alone or based on mini-grids, offer a solution to rural areas with little or no grid access. In other countries, mini-grids are used to power post-harvest processes, including milling, oil-pressing and ice-making, but usage can and should be expanded. Currently, crop losses disproportionately occur in the "first mile" between harvesting and processing. Providing renewables-based, decentralised cold storage to smallholder farmers and remote fishing communities in Zambia could therefore prevent spoilage of up to a quarter of the perishable foods currently produced in countries with less-developed cold storage (IRENA & FAO, 2021). In Kenya, for instance, decentralised renewables based cold storage infrastructure have reduced losses and improved market access for farmers, providing up to 30% additional income through aggregation and shortening of the value chain (IRENA & FAO, 2021).

Priority #8

Implement the Food-Based Dietary Guidelines supported by nutrition-sensitive interventions to achieve multiple and complementary outcomes.

The Food-Based Dietary Guidelines were developed through an evidence-based, context specific multi-sectoral process. It followed a food system approach to ensure alignment between different food-related policies and programmes, and support social and behaviour change communication for the population to adopt healthier, more sustainable diets. The document provides twelve recommendations for the public, and six recommendations for groups with special nutrition needs, such as pregnant and lactating women, and children (RZ, 2021c). Whilst the Pathway document makes specific reference to the need to operationalize these guidelines (2.2), it also provides for different entry points across the food system, such as improving the quality of food at schools and health

facilities, regulating the sale of safer and healthier food, as well as cross cutting actions relating to improved training as well as storage and processing facilities.

Raising awareness about the benefits of nutrient rich foods, such as orange fleshed sweet potatoes, iron rich legumes, and orange maize, are also singled out in Pathway 2, action 7. It is suggested that outreach could be strengthened by programmes that incentivise the production of these crops at household level, drawing lessons from previous programmes which, in collaboration with Harvest Plus, targeted the increased uptake of orange fleshed sweet potatoes between 2013 and 2022. These projects, implemented in all ten provinces in the country, involved the distribution of sweet potato vines with demonstration and training. An evaluation revealed that the project was a success and there was a recommendation made to scale-up going forward (Girard et al., 2021).

Given the high levels of wasting and stunting, a glaring absence in the Pathway document is a dedicated focus on improving child nutritional status within the first 1000 days. Zambia should take note of the findings of a systematic review on the effectiveness of social behaviour change interventions that showed that nutrition social behaviour change communication interventions can significantly improve exclusive breastfeeding practices and child anthropometric outcomes (Mahumud et al., 2021). Moreover, evidence from Bangladesh shows that combining cash transfers with intensive nutrition behaviour change communication activities can significantly improve chronic undernutrition with a significant improvement in height-for-age, driven by larger improvements in child diet – especially in terms of increased animal source food intake (Ahmed et al., 2024).

Priority #9:
Large-scale food fortification and biofortification

Interventions in the Pathway document advocate for the scaling up and intensification of existing food fortification policies and programmes that contribute to the reduction of micronutrient malnutrition (1.10 and 2.7). In this regard, the National Food and Nutrition Commission (NFNC) developed a comprehensive strategy and plan of action to ensure micronutrient deficiency prevention and control programmes were in place. The strategy and action plan makes provisions for the fortification of sugar with vitamin A; exploration of the fortification of maize meal with a micronutrient mix; and iron and folic acid (IFA) supplementation for pregnant women (RZ, 1999). However, the benefits of sugar fortification deserve further examination.

Zambia's 1998 mandatory sugar fortification Act aimed at supplying nearly 300 vitamin A (RAE) per capita daily. However, lack of compliance by manufacturers and poor oversight and monitoring by the government has led to less-than-optimal outcomes. Testing in 2017 revealed that the bulk of fortified sugar fell short of meeting the government's mandated minimum vitamin A content for all sugar produced (Greene et al., 2017). Only 11% of the sugar products tested met the threshold (Fiedler & Lividini, 2014). The lack of compliance and monitoring, coupled with the low consumption of fortified sugar (only consumed regularly by about 11% of Zambian households) has unsurprisingly not reduced vitamin A deficiency by much (Fiedler et al., 2013). Moreover, and considering rising levels of overweight and obesity in Zambia, sugar fortification can have unintended outcomes, such as an increase in overweight, obesity and non-communicable diseases (Kapulu et al., 2021).

Biofortification shows promise as a long-term investment that can potentially be a highly cost-effective intervention to combat micronutrient deficiencies. Assuming a 20% adoption ceiling over 30 years, the implementation of provitamin A maize (PVAM) is projected to have significant nutritional and health benefits. On average, it will lead to an additional vitamin A intake equivalent to 12% of the Estimated Average Requirement (EAR), a 3-percentage-point reduction in the prevalence of inadequate intake, and a 23% reduction in total DALYs (Disability-Adjusted Life Years). The benefits are particularly pronounced among farming households that adopt PVAM and consume it from their own production. For these households, the average additional vitamin A intake will be 172 µg/day, over three times the additional intake for the general population (54 µg/day). This group will experience a reduction in the prevalence of inadequate intake by 17.5 percentage points—more than five times the national average reduction. When valuing a DALY at USD 1,000, the cumulative value of DALYs saved by PVAM will exceed its cumulative total costs starting in 2019. Over the 30-year period, the cost-effectiveness of PVAM in Zambia is estimated at USD 24 per DALY saved, classifying it as a highly cost-effective intervention (Lividini & Fiedler, 2015).

Priority #10:

Social protection programs such as food banks, school feeding programmes, and weather-responsive cash transfers

Whilst the primary objective of cash transfers is to improve food security and consumption, they are also potentially important drivers of livelihood diversification and economic development. Analysis conducted over three years of 2519 and 3078 household recipients of unconditional cash transfers, under the Child Grant Program (CGP) and the Multiple Category Targeted Program (MCP) respectively, provides strong evidence of significant productive effects, leading to income multipliers of around 67% through investment in livelihood diversification and asset accumulation (Handa et al., 2018).

At present, the pathways make provision for food banks (5.7) and policies to empower women and youth to be more resilient, with the intention to upscale social safety net programs with appropriate targeting of beneficiaries. Zambia is already prioritizing the need for increased social safety nets, as is evident from the increasing allocations in their National Budget. The 2023/2024 budget saw an increase of ZMW 1.6 billion, from ZWM8.1 billion in 2023 to ZMW 9.7 billion, for social protection related expenditures covering the Social Cash Transfer Programme and Food Security Packs using a similar allocation to 2022/2023 (PWC, 2023). In 2023, the Social Cash Transfer Programme (SCT) and Food Security Packs reached 1,374,469 households, up from 973,323 households in 2022. Collectively, these programs reached 6,872,345 poor and vulnerable persons, representing approximately 34% of the population, 57% of the poor population, and 71% of the extremely poor population (UNICEF, 2023).

Given the evidence that points to the developmental benefits of cash transfers, it is recommended that Zambia considers the expansion of existing programs. In particular, Food Security Packs, aimed at vulnerable, but viable, smallholder farmers, have been shown to be effective at reducing poverty, especially amongst female-headed households and households with elderly members who benefit relatively more. It is therefore suggested that Zambia considers expanding such efforts further as a more cost effective approach

than the FISP which, although targeting smallholders, has less focus on vulnerability (Pirttilä, 2023).

Zambia should also consider weather-responsive cash transfers and seasonal loans for the pre harvest 'hungry' season as well as post harvest, as part of the envisaged review of existing policies and criteria of social cash transfers (Innovation Commission, 2023a). In Bangladesh, for example, a World Food Program used data-driven forecasting to send cash transfers to households about to experience severe flooding. This resulted in recipients 36% less likely to go a day without eating and more likely to move assets, livestock, and family members to safety, reducing the potential losses and improving their ability to cope with the disaster (Innovation Commission, 2023a).

Moreover, synergies between public food procurement, food security, and nutrition can be unlocked when the government purchases target traditional crops that address the nutritional requirements of vulnerable populations from small-scale farmers. Used strategically, public institutional food procurement can be an effective instrument to improve food security and nutrition. It also improves the livelihoods of small-scale farmers, by providing a predictable and reliable demand for agricultural products, thus reducing the risks and uncertainties involved in market participation. In Zambia, food procurement for public schools under the Home-Grown School Feeding program (PMRC, 2021) offers the potential to stimulate agricultural productivity and improve food security by creating an accessible market for smallholder farmers by supporting local production (FAO, 2021). This project, focused on children in grades 1-7, is supported through the Ministry of General Education.

2.3 Policy alignment

Increasingly there is policy convergence within Zambia as evident by the alignment of the Pathway document with existing and newly developed policy frameworks and strategies within the country.

Under the auspices of the 8th National Development Plan (8NDP) (RZ, 2021a), which identifies the agriculture sector as one of the key national strategic areas that is critical in ensuring economic transformation and job creation, Zambia has developed the Comprehensive Agriculture Transformation Support Programme (CATSP) as its Second National Agriculture Investment Plan (NAIP 11). The CATSP/NAIP II targets (1) increased food security; (2) improved nutrition; (3) increased job opportunities; (4) increased agricultural exports; (5) reduction in food imports; and (6) increased incomes and wealth creation opportunities (Zambia, 2022b). This provides opportunities for the implementation of the Pathway document, contributing to Zambia's achievements of SDG 2. It is, effectively, the implementation plan for all Zambia's agricultural policies and plans, including the 8NDP, the Food Systems Transformation Pathways, the Second National Agricultural Policy (2016) and the National Livestock Development Policy (2020) (RZ, 2022b; African Development Bank, 2023b).

The National Agriculture Policy 2012-2030 (NAP) is a cross-cutting policy with a vision to develop a competitive and diversified agricultural sector driven by equitable and sustainable agricultural development (RZ, 2011). It aims to increase the annual growth rate of real crop GDP and the value and growth rate of crop exports, contribute to the reduction

of poverty, and ensure food security among small-scale farmers. Key interventions in the NAP aimed at addressing poverty and food insecurity amongst small-scale farmers include: improving crop diversity; the production and consumption of crops that enrich the soil in rotation with food grains as a way to reduce fertilizer costs and increase yield and farm incomes; and the production and consumption of protein rich food crops, fruits, and vegetables to enhance diets and diversify income sources (RZ, 2011; IMF, 2023).

The NAP also targets inefficient farming methods with a focus on supporting appropriate farm mechanisation hire services for small-scale farmers to increase cropped area and overcome labour constraints, increase the area under irrigation to improve yields, promote intensification, and reduce rainfall-related production variations. The policy also targets upgrades in infrastructure including rural roads to reduce the cost of providing agricultural services and rural storage to reduce post-harvest losses. Lastly, and addressing the need to unlock increased investment by small-scale farmers, the policy makes provision to increase the number of farmers with title deeds. This is seen as an incentive to adopt sustainable land management practices, enhance the collateral value for accessing credit, facilitate access to affordable loans for farmer associations, and strengthen the capacity of farmer groups, including cooperatives to enable their members to produce adequate volumes for efficient marketing (RZ, 2011).

Zambia's nutritional challenges are also a vital component of key existing policies and plans such as the 8th National Development Plan, the National Agriculture Policy 2012-2030, and the Zambia Food-Based Dietary Guidelines. They have also been prioritized by the Government of Zambia in historic policies and plans such as the National Food and Nutrition Policy (2006) and the National Food and Nutrition Strategic Plan 2017 to 2021. Whilst the inclusion of nutrition in a variety of policies points to a more transversal rather than a silo-based approach to policy implementation, there is an unresolved tension between the Pathway document's strong focus on crop diversification and Zambia's drive to expand maize production under the Comprehensive Agriculture Transformation Support Programme (CATSP) (African Union, 2023).

The goal of the CATSP is to increase the annual maize production from the current 3.3 million metric tons to 6 to 10 million metric tons by 2027, through a doubling of the yields of smallholder farmers and an increase in commercial yields by 30%. In line with these goals, the government also aims to increase the national average yield per hectare from the present 1.72 metric tons to 4 metric tons per hectare by 2027 (RZ, 2022b). In the past, increases in maize yields were the result of an increase in hectares under production rather than increased productivity, putting pressure on Zambia's soil and water resources and leading to increased land use changes (see Box 1). Going forward, policies should focus on increased land productivity, rather than promote land expansion to ensure environmental sustainability (Adu-Baffour et al., 2019).

2.4 Trade-offs and synergies in the context of sustainable food system transformation

This report has already touched on the need to understand the trade-offs of any policy decision in the discussion on the consequences of an aggressive policy to expand maize production as well as potential policy measures that can be taken to mitigate negative

outcomes. Similarly, addressing the compound challenge of food system transformation considering climate change and the need to achieve healthy diets will not happen without trade-offs. For example, achieving healthier diets will require people to consume more diverse foods, including animal-sourced foods, which will lead to higher GHG emissions and land-use impacts, such as soil degradation and overuse of water resources. Improvements to diets delivered using existing technologies alone will exacerbate GHG emissions in agriculture and make it challenging to achieve climate change mitigation commitments.

Solutions need to build on the capacities of small-scale producers to simultaneously improve agricultural productivity while making production techniques that are GHG efficient more commercially viable alternatives. Increasing yields should focus on efficiency gains and narrowing the existing resource yield gaps through improved crop management that can, for example, more than double current yields of maize, rather than the aggressive expansion of land under crop production (Silva et al., 2023).

Zambia has policies that focus on improving agricultural productivity and on sustainable intensification and crop diversification at the farm level, as well as on improving value chains to address persistent food quality, availability, and affordability challenges. This emphasis on improved practices at the farm level means that specific policies, programmes, and interventions need to be designed to also foster climate change adaptation and build resilience, including promoting access to modern irrigation, renewable energy, and adjusting planting practices and crops, as well as supporting post-harvest storage.

Moreover, Zambia's ambition to drive poverty reduction and support a change in food supply and demand, together with factors such as urbanisation, supermarket expansion, open markets for food companies and shifting diet preferences will likely lead to a "nutrition transition" in diets. This can create health challenges associated with obesity and diet-related diseases such as diabetes or cardiovascular disease. These linkages demonstrate the importance of identifying policy interventions and related public and donor costs to influence both production and consumption patterns that lead to better environmental and nutritional outcomes. In this context, identified policy efforts that promote nutrition education and access to affordable healthier foods while accounting for consumer preferences can help reduce these tensions. For example, Zambia already has specific policies, linked to agricultural development, to address nutrition and food security challenges by improving access to healthier foods, both from the demand and the supply side (RZ, 2011; 2021a; 2022a). Many of these interventions are considered in Zambia's policies, especially those on irrigation, sustainable management practices, and post-harvest loss reduction.

Zambia will need to decide what trade-offs it is willing to make based on the best available evidence while maximizing synergies at the same time. To some extent, new policies and interventions can help manage and mitigate the tensions. For example, Zambia's strong focus on improving productivity and addressing GHG emissions from agriculture, together with efforts to improve value chains, by reducing food loss and waste, for example, can contribute to increasing food availability. In this context, the production of animal protein would need to become more GHG efficient to balance the trade-offs between the required significant increase in animal-sourced foods for healthier diets and the need to minimize agricultural GHG emissions. These efforts should go together with addressing the immense productivity gap in agriculture, particularly in the livestock sector. This is typ-

ically achieved through more and better feed and improved animal health—and most of these measures are included in Zambia's agricultural development strategies.

However, tensions will be created not only at the level of actual measures but also during policy development, coordination, and review. Integrating a focus on nutrition and healthier diets into agricultural and food security efforts and programmes could help increase positive synergies from limited resources. Thus, improving the capacities of agencies both vertically and horizontally to promote coherence and adopting a multisector approach could help prioritize interventions with benefits across different sectors and help address implementation issues. While donor-implemented projects already address the need for capacity development of state and national governments (USAID, n.d.a), to strengthen policy systems relating to resilience, food and nutrition security, and agriculture (European Union, 2022), and to design more effective policies relating to agricultural production and investment flows (USAID, n.d.b; IFAD, n.d), greater efforts are needed to identify additional sources of financing, both from domestic and donor sources.

Finally, as mentioned earlier, indicators for farm-level, individual, household, system-wide, and aggregate outcomes need to be designed in a way that would account for possible trade-offs so that policy-makers and other stakeholders are able to track progress in managing these trade-offs and adjust policies along the way.

Chapter 3:
COST OF ACHIEVING A SUSTAINABLE FOOD SYSTEMS TRANSFORMATION IN ZAMBIA

Achieving sustainable food systems requires a holistic approach to support the desired change within the food system, including both poverty reduction and the creation of a secure, diverse and safe food supply. Such change in food supply and demand will lead to a nutrition transition, creating environmental and land-use impacts that range from changing production patterns, including soil degradation, overuse of water resources, and increased GHG emissions, as well as health challenges associated with obesity and diet-related diseases. These linkages demonstrate that market-based solutions alone will not produce outcomes that simultaneously address environmental and climate constraints while meeting nutritional targets. Thus, the core focus is to identify policy interventions and related public and donor costs to influence production and consumption patterns that lead simultaneously to better environmental and nutritional outcomes.

3.1 Portfolio of interventions

The complexity of the interrelationships among the key food system challenges requires a balanced mix of interventions. For example, the necessary changes in consumption patterns to progress toward healthier diet targets will require, and trigger, changes in production patterns. Those changes will have to be compatible with the shift toward a more resilient agriculture and food system, in particular in the context of climate change mitigation (reduction of GHG emissions) and adaptation (resilience to weather variability and the changing climate). While climate-smart agriculture addresses production-side issues, diets must also adapt to allow for more environmentally sustainable food systems. Food system interventions should, therefore, not be considered as isolated fixes but rather as an integrated portfolio designed to meet complex objectives.

The set of interventions included in the economic model (MIRAGRODEP) represents such a portfolio of interventions, designed to leverage synergies and balance trade-offs within food system transformation. In total, there are 15 interventions integrated into the model, categorized into three broad action areas – "Empower the Excluded," "On the Farm," and "Food on the Move." The list of interventions and their breakdown into categories are summarized in Table 1, with further information on the interventions selected provided in the Annex.

Interventions in the model support the achievement of Zambia's climate change adaptation goals through investments in improved planting and crop choices, irrigation and soil management, and access to improved storage and markets (see Table 1). For example, interventions On the Farm provide direct support to farmers to produce more food, improve production quality, and increase production diversity, which contributes to climate

adaptation and resilience building. The model also includes interventions that collectively offer some proxy for interventions to improve the GHG efficiency of animal agriculture, such as R&D, extension services, and livestock subsidies for agroforestry and improved forage. The GHG limits also bias the model against ruminant meat since ruminants are much more GHG intensive per calorie than eggs, poultry, pork, fish, and other non-ruminant animal-source foods.

Finally, while the model is not able to integrate institutional reform and capacity building, this is the foundation for the success of any of the policy interventions. Such institutions are also critical to monitor the achievement of the portfolio of interventions, using appropriate indicators for farm-level, individual, household, system-wide, and aggregate outcomes to cover productivity improvements as well as climate change impacts on production and the agricultural sector's resilience, including that of small-scale producers.

Table 1. Policy interventions included in the model

Category	Interventions in the model
Empower the Excluded	Social protection (food subsidy)
	Vocational training
	Nutrition education
	School feeding programmes
On the Farm	Investment subsidy
	Fertilizer subsidy
	Production subsidy
	Capital endowment
	R&D
	Extension services
	Rural infrastructure (irrigation)
	Livestock subsidy (agroforestry)
	Livestock subsidy (improved forage)
Food on the Move	Storage post-harvest losses
	Rural infrastructure (roads)

Note: Green shaded interventions are linked to climate adaptation

3.2 Quantitatively defining sustainable food systems

A series of quantitative targets are needed to enable the MIRAGRODEP model to allocate costs across the policy interventions, including a breakdown of the costs between domestic and external resources. The findings from the stakeholder consultations, literature review, and microeconomic analysis are applied to the MIRAGRODEP model hybridized with microeconomic household data to project two future scenarios until 2030 and 2035 respectively:

- **SDG 2 scenario:** This scenario provides costs for addressing the priorities identified in the Pathways document and that are aligned to the SDGs. In this scenario, the prevalence of undernourishment (PoU) is reduced to less than 3%, nutritious food targets to achieve healthier diets are reached (e.g., fruits and vegetables and animal-sourced proteins), the net incomes of small-scale producers doubles on average in 2030 compared to 2015 levels, and agriculture-related GHGs are kept to the countries' NDCs.

- **2035 scenario:** This scenario provides costs for addressing the priorities identified in the Pathways document with a 2035 timeline. In this scenario, the PoU is reduced to less than 3%, the number of people that can afford a healthy diet is doubled, from 20% to 40%, doubling the percentage of people consuming a healthier diet, the net incomes of small-scale producers doubles on average in 2035 compared to 2015 levels, and agriculture-related GHGs are kept to the countries' NDCs.

Both scenarios require that all households achieve caloric sufficiency, but also demand that households achieve healthier diets. In this way, diversification is promoted without compromising hunger.

For the most part, these all have clear, widely accepted and modellable quantitative targets (see Annex). However, there is currently no universally accepted definition of a healthy diet. And yet, in order to estimate costs, there is a need to establish a healthier diet target in the model. Given the level of details and targets in Zambia's Food Based Dietary Guidelines, the targets for the model are derived from those guidelines and complemented with international guidelines:

1. **Overall caloric intake is measured** using the prevalence of undernourishment (PoU) as a metric, with a target of less than 3% PoU.

2. **Adequate consumption of non-starchy vegetables and fruits,** based on the WHO guidelines of 400 g of fruits and vegetables per day (WHO, 2020).

3. **Adequate consumption of animal-source foods** (including dairy) through a minimum target of at least 10% of households' overall caloric intake to ensure sufficient calcium and B12.

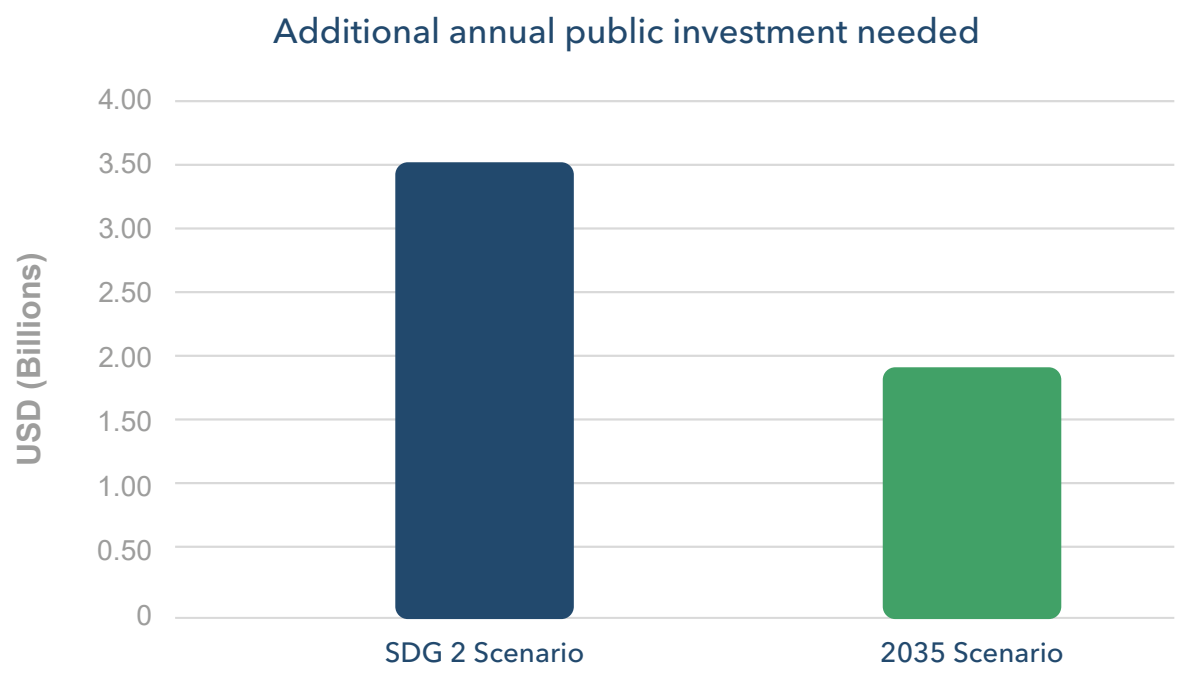
3.3 The financing gap

The results from the modelling show that if Zambia is intent on achieving its SDG 2 targets by 2030 it will require an additional USD 3.5 billion in annual public investment from now until 2030, the bulk of which will be allocated to social protection programmes (see Figures 13 and 14). These recurring payments would need to continue after 2030 to continue meeting the SDG 2 targets. Not only is the level of spending incredibly high, but a prioritisation of cash transfers will result in the underfunding of effective longer-term interventions that are critical to achieve sustainable and long-lasting food system transformation. By adopting more modest targets over a longer period, funding goals are more achievable and spending more transformational, and can be phased out.

By shifting the target year to 2035 and seeking to achieve a more pragmatic target of doubling the number of people that are able to afford a healthy diet, the additional annual investment required is USD 1.9 billion (see Figure 13).

Zambia needs an additional USD 1.9 billion public investment to transform its food systems by 2035

Figure 13. Total annual additional public funding required to achieve SDG 2 by 2030 compared to a 2035 scenario in Zambia



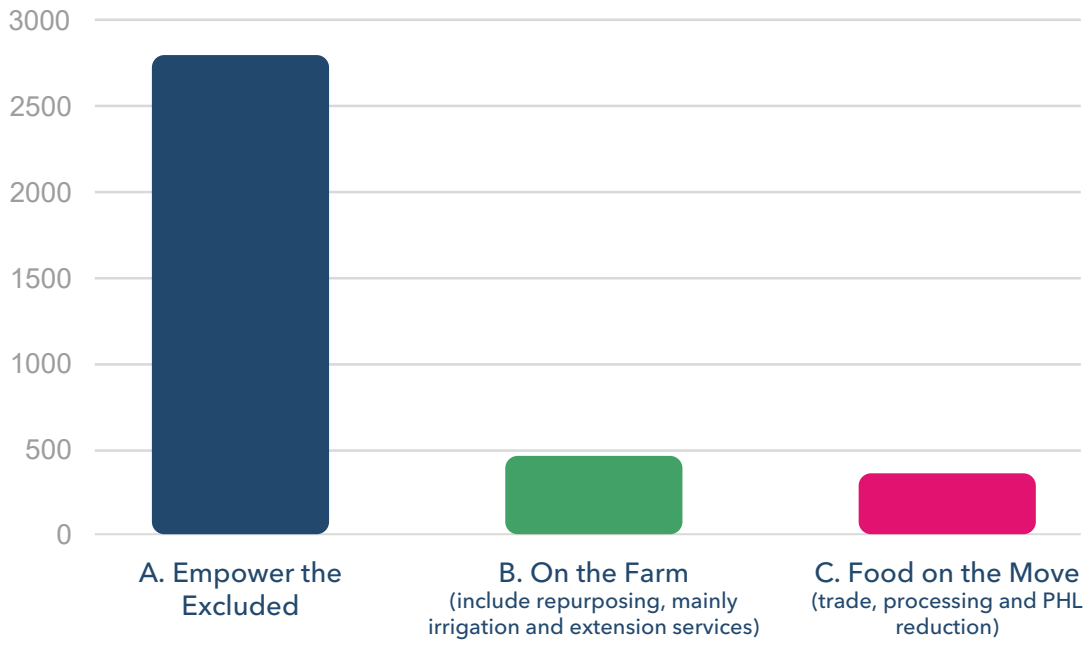
Source: Authors' own based on MIRAGRODEP model simulations

The total costs are important, but so are the allocations to specific interventions, the financing gap compared to historical ODA flows, and the policy and strategic support to promote the implementation of these interventions and priority areas identified in Section 3. In this context, it is critical to allocate funding to the actions and programmes outlined in existing policies and strategies and, complement existing efforts with additional actions informed by evidenced based best practice in Zambia and elsewhere.

The composition and level of spending depends on the timeline to achieve the goals. In the SDG 2 scenario, given the 2030 timeline, there is insufficient time to reap the rewards of structural investments and longer-term development investments. Therefore, social protection constitutes the majority of the additional spending and will be much larger compared to scenarios that consider a longer time horizon. However, this level of spending and the funding of food systems transformation through cash transfers is not sustainable. Furthermore, the shortfall in longer-term funding will increase Zambia's vulnerability to shocks and crises, pushing up the number of people affected by hunger and poverty.

Achieving SDG 2 in Zambia by 2030 will require an extra USD 3.5 billion per year, mostly in the form of cash transfers

Figure 14. Total annual public funding required to achieve SDG 2 by 2030



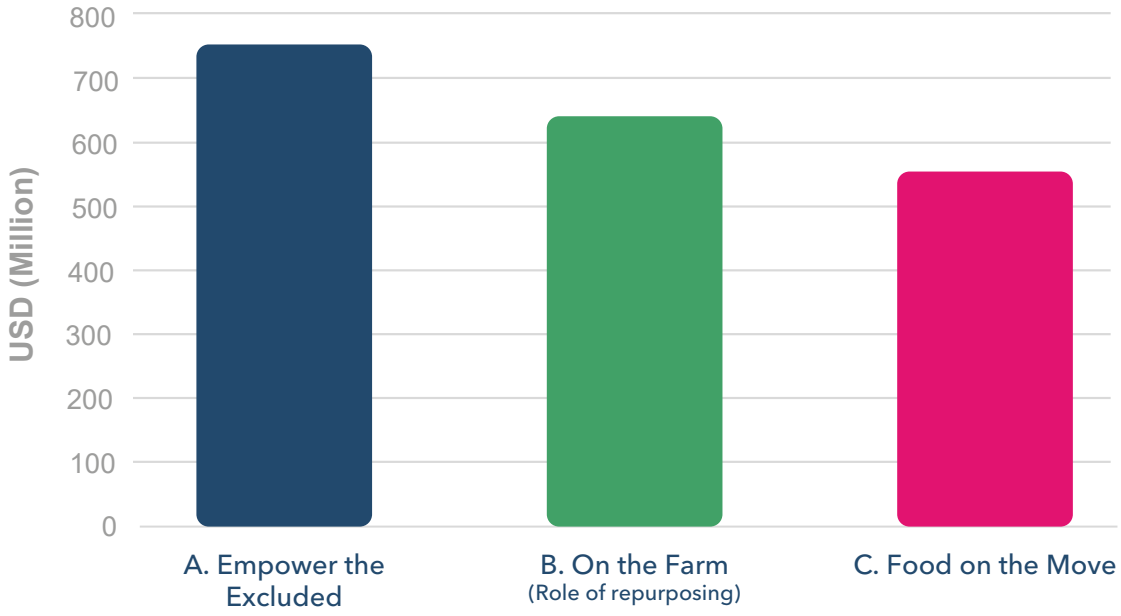
Source: Authors' own based on MIRAGRODEP model simulations

When considering a longer timeline, there is a more even distribution of investment across the three main areas of intervention in the agrifood system (see Figure 15). This reflects the sufficient amount of time to invest in longer-term development priorities in

order to support resilience building that would help mitigate against future shocks and crises. An additional USD 620 million per year on average is needed to improve farm productivity and incomes; an additional USD 740 million per year on average is needed for social protection, education, and school feeding programmes; and an additional USD 550 million per year is needed to move food to markets.

A longer timeframe allows for a more even distribution of investment

Figure 15. Total annual public funding required to progress Zambia's food systems by 2035



Source: Authors' own based on MIRAGRODEP model simulations

The largest share goes to social protection programmes, vocational training, nutrition education, food banks and school feeding programmes, to support consumption of adequate, sufficient and nutritious food.

Interventions on the farm provide direct support to farmers to produce more food, improve production quality, and increase production diversity. Production interventions not only lead to income improvements and address low agricultural productivity, but also result in improved access to healthier foods, such as fruits and vegetables and animal-source foods. As suggested during consultations and supported by the literature, these complement—and need to be complemented by—other nutrition focused measures such as nutrition education, food banks and school feeding programmes to have maximum effect on dietary outcomes.

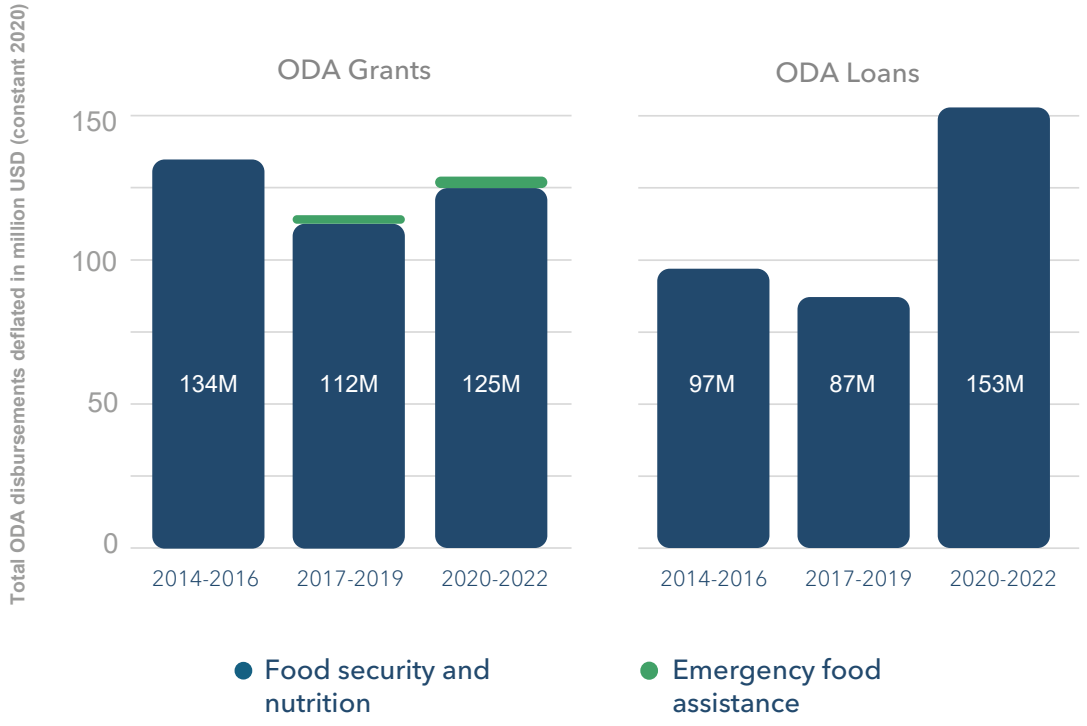
Finally, interventions are needed to develop agrifood systems, infrastructure and markets. This is closely linked to farm-level measures and links producers to consumers. These interventions directly contribute to dietary diversity, as households with better access to

local markets tend to have higher dietary diversity. In addition, promoting access to storage, especially for nutritious foods (such as vegetables, fruit, and animal-source products), helps improve the nutrition of households accessing these foods.

To contextualise the required increase in public spending in both scenarios, in 2020-2022 donors provided USD 125 million in grants and USD 153 million in loans to Zambia (see Figure 16). Over the past decade, the volume of ODA received by Zambia has increased, however this has mostly been in the form of loans. Whilst the volume of grants received by Zambia has slightly decreased, from USD 134 million in 2014-2016 to USD 125 million in 2020-2022, the volume of loans has been steadily increasing, from USD 97 million to USD 153 million in the same period. Indeed, in 2020-2022 loans formed most of the donor financing received by Zambia.

Zambia currently receives on average USD 125 million in grants and USD 153 million in loans per year from development partners

Figure 16. Historic financing for emergency food assistance and long-term investment in food security and nutrition in Zambia, 2014-2022



Note: For each period the yearly average is indicated
Author analysis of OECD's Creditor Reporting System (OECD, 2024)

Emergency food assistance has remained negligible in the composition of Zambia's ODA, reflecting the stability of the country. However, Zambia has been suffering from recurring drought cycles with dire consequences for its maize production leading to hardship and famine which require emergency humanitarian assistance. It is expected that the next funding cycle will contain larger provisions for such assistance in response to the current protracted drought that has led to the country declaring a state of national disaster and emergency.

An examination of the national budget shows allocations to the agriculture sector declined from 9.3% in 2015 to 3.7% in 2020 which is well below the African Union's Comprehensive Africa Agriculture Development Programme (CAADP) commitment of at least 10%. However, in the 2023/2024 budget, the allocation to the sector has increased by 23% from USD 463.4 million in 2022/2023 to USD 571 million. In the main, this will be spent on the launch of the Comprehensive Agriculture Transformation Support Programme as part of the FISP reform programme to include extension services, extensive road construction to increase accessibility within farm blocks, new power lines to farms, and the continued implementation of smart agricultural technologies such as conservation agriculture, water harvesting, adaptive research, on-farm research programmes, agricultural insurance, as well as early warning systems in collaboration with cooperating partners (PWC, 2023).

Whilst the increase in budgetary and donor allocations indicates a step in the right direction, as the modelling results show, more is needed to operationalize the Pathway document and achieve food systems transformation in Zambia.

3.4 Beyond ODA: the role of innovative finance

It is becoming increasingly clear that it is unlikely that Zambia will be able to attract enough donor funding via grants to meet the investment gap estimated by the model. Existing grant funding is already augmented by concessional loans from multilateral and bilateral development banks, but despite these efforts, development finance alone will be insufficient to fill the investment gap to achieve SDG 2. More is needed to make other sources of development finance work, including commercial loans from multilateral and bilateral development banks, and blended finance from both public and private sectors.

In this regard, the EU is already considering the use of blended finance. They have been working closely with European and international financial institutions active in the targeted sectors to better understand how a mix of financing instruments such as blending, grants with CSOs, contribution agreements with the UN and EU multi-sectoral development agencies, or partnerships with private sector may be considered to support programmes in Zambia (EU, 2022).

Another option is to use public financing projects to create incentives to attract more funds from the private sector and cooperating partners. Private sector financing could also be used to promote, develop, disseminate, monitor, evaluate, and coordinate best practices that are already being implemented (IMF, 2023).

Carbon finance also provides opportunities to unlock longer term revenue that can be reinvested. Under the Zambia Integrated Forest Landscape Project (ZIFLP), a mix of grants and, led by Zambia's Ministry of Green Economy, carbon finance is used to incentivise the adoption of climate smart agriculture (CSA). To enable smallholder farmers to reap the benefits of carbon finance, the programme integrated CSA into the monitoring reporting and verification (MRV) system through a novel modelling technique combining climate, soil, and land management data to estimate the turnover of organic carbon in the soil. The soil's organic carbon baseline will be compared against soil carbon sequestration resulting from the adoption of CSA interventions, and the carbon savings will trigger payments to the farmers through a benefit sharing plan (Biocarbon, 2023).

CONCLUSIONS

Zambia is not on track to achieve the United Nations Sustainable Development Goals by 2030. Its lack of progress is further exacerbated by the country's maize-centric and rain-fed agriculture sector that is vulnerable to recurring drought cycles predicted to worsen with climate change. To get back on track, it is critical to pursue policy pathways that favour synergies and limit the trade-offs between hunger, poverty, nutrition, and climate change. This report presents an evidence-based prioritization of effective interventions to operationalize Zambia's Food Systems Transformation Pathways to end hunger, make diets healthier and more affordable, improve the productivity and incomes of small-scale producers, and mitigate and adapt to climate change.

Without additional investment, significant levels of hunger, malnutrition, and poverty will persist after 2030. By 2030, economic growth in Zambia will be insufficient to reduce the number of people affected by hunger and poverty. Without additional investment and more effective policy interventions, the poverty rate in 2030 will remain high at just over 60%, while the hunger rate will decrease very slightly to 30% in 2030. Healthy diets are and will continue to be unattainable for more than 80% of Zambians by 2030.

Zambia can achieve its SDG 2 goals by 2030 by increasing public investment by USD 3.5 billion per year, largely in the form of cash transfers. The prioritization of cash transfers over and above more systemic interventions is due to the limited time available to reduce the country's existing high levels of poverty, hunger and malnutrition.

However, this level of spending and the funding of food systems transformation through cash transfers is not sustainable. Not only is the level of spending incredibly high, but a prioritisation of cash transfers will result in the underfunding of effective longer-term interventions that are critical to achieve sustainable and long-lasting food system transformation. The shortfall in longer-term funding will increase Zambia's vulnerability to shocks and crises, pushing up the number of people affected by hunger and poverty.

Neither is narrowly investing in maize the answer. At the specific request of the leadership of Zambia, the report also modelled the investment required to double maize yields by 2030 to develop a better understanding of the trade-offs of pursuing an aggressive expansion of maize production to address domestic food security as well as drive exports. Whilst demonstrating positive increases in GDP and yields, this investment strategy results in smaller gains in hunger and poverty and risks poor nutrition due to the crowding out of more diverse and nutritious crops.

Alternatively, it is possible to achieve a sustainable food systems transformation in the next 10 years with an additional public investment of USD 1.9 billion per year from 2024-2035. This should be allocated to longer-term development priorities in order to support resilience building that would help mitigate against future shocks and crises as well as maintain greenhouse gas (GHG) emissions in agriculture to Zambia's nationally determined contribution (NDC) goals, and increase resilience to climate change.

Critically, achieving sustainable food systems transformation is not just about the volume of spending but how the spending is allocated. The complexity of the interrelationships among the key food system challenges requires a balanced mix of interventions. Food system interventions should, therefore, not be considered as isolated fixes but rather as an integrated portfolio designed to meet complex objectives.

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ANNEX

Methodology

Methods for researching and modelling food system transformation

This section presents the methods and approaches used, including a review of academic and grey literature, policy documents, national plans and programmes, donor-funded projects, three rounds of stakeholder consultations, and microeconomic modelling to map dietary diversity and macroeconomic modelling to estimate the additional public costs of policy interventions.

Literature review and consultations

The literature review focused on peer-reviewed literature, reports and briefing notes developed by major agencies such as the FAO, the World Bank, major development agencies (GIZ, USAID, UK Aid, and others), as well as the country's policy documents. To access peer reviewed literature, we searched the ScienceDirect database (www.sciencedirect.com) for papers focused on Zambia and papers outlining regional trends with specific details on Zambia regarding issues such as climate change adaptation, food security, nutrition, and agriculture.

We covered the period from 2010 -2023 (papers in pre-publishing). A total of 4345 papers were collected. The research team briefly screened the abstracts of the papers, prioritizing interventions that aligned with Zambia's pathway and have demonstrated cross-cutting impacts in improving food security, nutrition, livelihoods of small-scale farmers and climate reliance where possible. Findings from peer reviewed articles are included in the report. For reports and briefing notes by international and government agencies, we visited the agencies' websites and reviewed their publications for the 2010–2023 period. A total of 45 documents were collected.

In addition, we reviewed strategies and policy documents published by ministries and government agencies in Zambia and selected 20 documents for the 2010–2022 period. The findings from these sources informed our understanding of current trends and policy-making priorities with respect to agriculture, food security, nutrition, and the environmental and climate change impacts of agricultural production. They informed the consultations as well as the selection of interventions included in the model.

Stakeholder consultations

Stakeholder engagement is critical to develop joint ownership of the recommendations and increase the probability of utilization of the research. To this end, a series of online and in-person consultations were convened that offered stakeholders the opportunity to contribute and provide feedback on the research process, results, and findings at various stages.

The project encompassed three rounds of country-level consultations which focused on linking the research conducted in the two other components – the large-scale modelling exercise based on the MIRAGRODEP modelling framework and the research into food demand behaviour at the household level - with the country policy and institutional environment and ongoing projects.

More specifically, the objectives of the consultations were fourfold:

- To ensure political buy-in of the research through building an understanding of the research methodology and modelling outcomes
- To develop a granular understanding of country priorities to identify impactful policy interventions that can, where possible, be integrated in the modelling exercise
- To validate our operational definition of healthier diets in each country and guarantee that various stakeholders feel confident in using our criteria
- To disseminate the results of the research and invite feedback on the research process and findings to develop joint ownership on the final recommendations and increase the probability of utilization by the country and inform funder strategies

First round

The first round consisted of a series of consultations with Zambia's food system transformation leadership team aimed at securing the political buy-in for the research, developing a shared understanding of the project methodology and clarity on the outcomes of

the research. This was an iterative process. The key outcomes of this round of consultations were twofold. First, there was the request to incorporate a modelling exercise in the research output on the costs, benefits, and trade-offs of doubling maize yields in Zambia by 2030. Second, there was agreement that the existing SDG targets to end hunger and malnutrition were too ambitious and that the model should also make provision for more realistic targets.

Second round

The second consultation was a workshop in Lusaka in August 2024. The workshop, convened by the Zero Hunger Coalition in collaboration with Zambia's National Food and Nutrition Commission (NFNC), aimed to:

- Share the evidence-based findings and deepen the understanding of the economic model used to determine the costs required to transform Zambia's food systems
- Highlight the evidence-based and investment gaps essential for successfully transforming Zambia's food systems between now and 2030
- Discuss the balance between short-term achievements and long-term goals to ensure sustainable outcomes

The consultation was attended by a diverse group of 50 participants representing the Office of the Vice-President, the NFNC, relevant ministries - local government, and rural development, agriculture, community development and social service - as well as key stakeholders - FAO, GIZ, USAid, UNICEF, WFP, AUDA-NEPAD, EU and Irish Aid.

The workshop shared the results of the research to date focussing on priority interventions and the FAO presented two modelling results. The choice of the modelling exercises aimed to sensitize participants about the trade-offs of pursuing two specific policy trajectories: ending hunger by 2030 and doubling maize yields by 2030.

In the plenary, and in response to the target that aimed to end hunger by 2030 in the model, participants raised their concerns about the aggressive roll-out of cash transfers required to achieve this goal and how this will impact on the country's already constrained fiscal situation. Responding to this, the report also modelled what it would cost to achieve a more realistic target of doubling the number of people that are able to afford a healthy diet by 2035.

Linked to this was the need to be intentional and context sensitive when planning and upscaling interventions as well as scaling existing programmes such as agro-processing initiatives aimed at reducing food loss. Biofortification and fortification as well as the roll-out of a sugar tax were mentioned as impactful interventions where the private sector can play a significant role.

Contributions from the audience clearly demonstrated a need for more specific costing of interventions as well as understanding the costs of inaction and the return on the different investments. These are particularly relevant given the fact that agriculture is a resource intensive sector. Given the fiscal constraints of the country, there is also a need for a rigorous process to identify priority interventions.

Key outcomes of the workshop were the acknowledgment that the research and modelling provided a resource to the Food System Technical Working Group to shape the food, climate, and nutritional future of the country by isolating actionable and impactful interventions and supporting high level guidance on future costing.

Desktop review of donor-funded projects

The consultations aimed to assess how food security, environmental sustainability and healthy diets are integrated in various agencies' strategies and national policy framework. It identified existing initiatives and projects aimed at incentivizing healthy diets (consumption lens) as well as projects aimed at fostering the climate smart production of nutrients-dense food.

Quantitative modelling

This study integrates findings from the literature review and consultations into a combined micro and macroeconomic model for Zambia's food system. This model is based on the analytical framework developed in the Ceres2030 project.

At the microeconomic level, we analyzed trends in diets, food preferences, and nutrition using data from the Zambia Living Conditions Survey (LCMS), 2015. It is a nationally representative household survey that contains data from 12,251 households, covering all 74 districts, and 95 distinct food items. The raw data provides quantity information on food consumption at a very disaggregated level by each household. These items are then mapped to standard nomenclature, consistent with the products of FAOSTAT's food balance sheet (FBS). After standardizing the food items, they are mapped according to eight primary food groups:

- cereals and starches
- legumes, nuts, and seeds
- vegetables
- fruits
- dairy
- animal products (excluding dairy)
- vegetable oils
- sweets and alcoholic beverages

The microdata was also used to perform a cluster analysis: a data-driven approach that allows households to be classified based on commonalities in observed diets, complementing top-down analysis based on observed household characteristics (such as urban/rural status). The detailed microdata enabled us to estimate a demand system for the country so that our CGE model estimates of how dietary patterns change in response to changes in income are driven by household survey reports.

The nutrition profile analysis also mapped the calorie, protein, and fat intake (per capita) by eight food groups. All numbers have been weighted by sampling weights of the sur-

vey. Appropriate nutrition coefficients for each item available in the survey were derived using FAOSTAT's food balance sheet and the nutritional contents of the food items computed by converting quantity data to various dimensions of nutrition - calorie, protein, and fat intake.

Scenarios for Identifying policy pathways and costs

To identify potential pathways for food system transformation, the findings from the stakeholder consultations, literature review, and microeconomic analysis have been used to apply a CGE model hybridized with microeconomic household modelling to project two future scenarios for 2030 and 2035:

- **SDG 2 scenario:** This scenario addresses the key challenges laid out in the report. Specifically, the PoU is reduced (to less than 3%), nutritious food targets to achieve healthier diets are reached (e.g., fruits and vegetables and animal-source proteins), the average net incomes of small-scale producers doubles in 2030 compared to 2015 levels, and agriculture-related GHGs are kept to the countries' NDCs.

- **2035 scenario:** This scenario provides costs for addressing the priorities identified in the Pathways document with a 2035 timeline. In this scenario, the PoU is reduced to less than 3%, the number of people that can afford a healthy diet is doubled, from 20% to 40%, doubling the percentage of people consuming a healthier diet, the net incomes of small-scale producers doubles on average in 2035 compared to 2015 levels, and agriculture-related GHGs are kept to the countries' NDCs.

These targets are related to SDG targets 2.1, 2.2, 2.3, and 2.4, respectively. Both scenarios require that all households achieve caloric sufficiency, but also demand that households achieve healthier diets. In this way, diversification is promoted without compromising hunger.

Establishing model targets for food system transformation

To model and provide a costing for sustainable food system transformation, quantitative targets are required. The model seeks the achievement of zero hunger (SDG 2.1), a nutritious food target to achieve healthier diets (SDG 2.2.), a doubling of the incomes and productivity of small-scale producers (SDG 2.3), and the constraining of GHG emissions in agriculture (SDG 2.4).

Hunger and poverty

Corresponding to SDG target 2.1, the model simulates the removal of households from the status of hunger, as defined by the FAO's PoU metric. Specifically, the level of undernourishment in the country is reduced to less than 3%.

Healthier diets

Zambia developed its Food-Based Dietary Guidelines in 2021. To estimate costs for achieving healthier diets, there is a need to establish a quantitative target in the model. Three quantitative targets are used in the model as key indicators of a healthy diet. With a food group-based approach, we model diets that are "healthier" than current diets rather

than achieving a "universally healthy" diet. Under current policy scenarios, "universally healthy" diets will not be feasible by 2030 for all Zambians. Additionally, there is no singular "healthy" diet since multiple healthy diets (diets that differ by the exact food group composition but are each healthy) are possible, and cultural acceptability, preferences, and other aspects of appropriateness can vary within Zambia. The targets therefore represent progress toward healthier diets, balanced with an assessment of what could feasibly be achieved in the next decade.

Based on national and international guidelines and policy documents, a review of nutrition literature, and expert consultations, we have focused on the following targets for achieving healthier diets in Zambia:

1. Overall caloric intake measured using the PoU, with a target of less than 3% PoU in each country.

2. Adequate consumption of non-starchy vegetables and fruits, based on WHO guidelines of 400 g of fruits and vegetables per day (WHO, 2020).

3. Adequate consumption of animal-source foods (including dairy) through a minimum target of at least 10% of households' overall caloric intake to ensure calcium and vitamin B12.

A set of targets for sufficient caloric intake at the household level is based on the modelling of household consumption in comparison to calorie requirements, adjusted for the age and sex of household members. For fruits and vegetables, a minimum target of 400 g per person per day is set based on WHO guidelines, adjusting for household demographic characteristics (WHO, 2020). As with caloric intake, the target is adjusted for each household in the sample based on the age and sex of its respective members. Vegetables and fruits are important for meeting a wide variety of micronutrient needs, including vitamin A and iron, which are commonly insufficient in diets. An overall minimum target for animal-source foods, including dairy, is set to at least 10% of households' overall caloric intake. The inclusion of animal-source food in the diet is a key means for at-risk populations, especially children, to get sufficient amounts of nutrients, such as zinc, iron, vitamin A, vitamin B12, calcium, and selenium. All targets apply to all households in the population. Full documentation of our dietary targets' selection can be found in Bizikova et al. (2023).

Smallholder Income

SDG target 2.3 envisions the net incomes of small-scale producers doubling on average between 2015 and 2030.

Climate Change Mitigation and Adaptation

While it is not possible to integrate climate change adaptation (SDG 2.4) directly into the cost modelling, it is important to achieve resilient agricultural production, and consideration of the impact of–and impacts on–climate change is central to our nexus approach. To reflect this, we follow the approaches of the water–energy–food (WEF) nexus that highlight the critical importance of including climate change impacts and responses. Climate change is integrated into the model by accounting for the gradual impacts of

climate change on crop production using FAO crop projections under climate change. This approach suggests that by 2030, climate change will lead to less than a 10% drop in production for major crops in Sub-Saharan Africa, especially if drought-resistant crops are planted (Malhi et al., 2021).

In the model, GHG emissions for agriculture conform to the commitments made in Zambia's NDCs (RZ, 2021b). In the model, the country has a carbon budget (permitted GHG emissions) for agriculture, and land-use emissions and emissions from energy and fertilizer use are included in this budget. The model maintains the budget through a domestically determined carbon tax.

Portfolio of Interventions

The interventions included in the model were selected based on their relevance for addressing the multi-dimensional challenges of the food system and their potential to deliver on hunger, diet, small-scale food producer income, and climate change mitigation and adaptation targets. At the systemic level—and through the model interactions—all the interventions contribute to improved diets and could lead to stronger resilience to climate change of the food system and its actors.

Nonetheless, how each intervention affects each of the four modelled targets can be complex, particularly because the model accounts for both direct and indirect effects on the economic system. However, there are some general rules for how the modelled interventions affect each target.

- SDG 2.1 (hunger): Generally, any intervention that increases household incomes can contribute to reducing hunger. For example, a social protection programme, like a food subsidy or direct cash transfer, increases the income of a household and their ability to buy more food.

- SDG 2.2 (nutrition): Similarly, anything that increases income allows people to improve their diets. As incomes increase, households tend to increase their consumption of animal-source foods, while increases in the consumption of fruits, vegetables, legumes, nuts, and seeds tend to be relatively insignificant compared to increases in income. Actions that decrease the price of important under-consumed food groups relative to other foods can also play a role in improving diets.

- SDG 2.3 (small-scale producers): Poverty reduction is critical in the countries studied. Thus, anything that increases the income of small-scale producers, including income from non-farm sources, or allows those unable to make a decent livelihood in agriculture the possibility to find another source of income, contributes toward the target of doubling the income of small-scale producers. Examples of this include investment subsidies to help small-scale producer households increase their agricultural income, vocational training to enable employment that is more lucrative than agriculture, or social protection programmes that provide non-farm income.

- SDG 2.4 (sustainable agriculture): Anything that improves the GHG efficiency of agricultural production or other components of the food system helps limit overall GHG emissions from agriculture and land use. While interventions such as agroforestry subsidies have obvious benefits for GHG mitigation, interventions like ferti-

lizer subsidies can also increase the overall GHG efficiency of a crop's production. When used in a context where fertilizer use and yields are very low (as is the case in Zambia), fertilizer subsidies can lead to land savings outcomes, delivering higher yields on existing cropland, which could reduce deforestation and slash-and-burn practices.

The impacts of climate change on average temperatures and rainfall are included in the model, but due to the 2030 time horizon, they play a minor role in the assessment. However, given the increased frequency and intensity of extreme weather events, there is a need to scale up public investment to increase the climate resilience of food systems.

Of the 15 interventions included in the model, nine contribute to building resilience and promote adaptation to climate change (see Table 1). While all the interventions should be designed and implemented in a diet- and climate-sensitive way, these nine interventions are in line with climate change adaptation priorities as stated in national policy documents, peer-reviewed literature, and stakeholder feedback. In addition to contributing to climate change adaptation, these interventions promote the economic resilience of small-scale producers and their households by improving food production and access to diverse agricultural inputs, increasing incomes, and providing access to financial services and social transfers for small-scale food producers with limited capacities. This type of synergistic approach, with interventions simultaneously progressing toward multiple, complex targets, is at the core of the food systems concept and critical to achieve the SDG 2 targets by 2030.

Limitations and challenges of the methodology

Approach

As with any nexus study, we face a number of challenges due to the complexity of the nexus's elements and its translation into a quantitative model. Limitations include our inability to incorporate gender issues, extreme weather/climate events, regional differences, and institutional challenges. The constraints we are most concerned about include modelling within-year variation in hunger and diets and modelling at the individual level, especially with respect to gender. This section provides an overview of critical aspects impacting the food system, including climate change, nutrition, and other challenges that we were unable to integrate into the model.

Data limitations

The microdata used in the analysis were intended to give the best possible representation of diets in Zambia. The primary data source Zambia Living Conditions Survey (LCMS), 2015 which forms the basis of our estimation of current and projected dietary trends.

Gender and other Individual characteristics

The unit of observation for the LCMS surveys is the household, and hence food consumption is reported at the household level. This is logical both from an economic perspective, since food resources are typically pooled (i.e., food is purchased for and consumed by the household), and, from a practical perspective, since it would be extremely difficult and costly to obtain individual-level food consumption data at a nationally representa-

tive level. A key consequence for the analysis is that it is now possible to observe the intra-household allocation of consumption items: while it is possible for a given household to observe what the average household member consumes, it is not possible to attribute individual consumption levels. For a household with male and female members, it is not possible to attribute the amount of a given food item consumed by males versus females, and hence it is not possible to make gender-disaggregated comparisons. This is an important limitation to the analysis that we hope can be addressed in the future through improved resources and methods for gender disaggregated data collection.

Seasonality and Its impact on diets

Many of the households in Zambia experience variation in the availability and price of different food items at different times of the year. This is particularly true of certain categories of perishable items such as fruits, which may only be available in some areas for limited periods. Similarly, where market integration is limited, the price of locally produced staple crops may be low around harvest season and high during planting season. These and other factors contribute to seasonal variations in diets, resulting in differences in the quantity of macro- and micro-nutrients individuals receive throughout the year. There is variation in the timing of surveys that allows us to partially observe seasonal variations across households (see Bizikova et al., 2023). However, since each household was not interviewed at all points in the year, we do not observe seasonal variations within households. Our estimates therefore reflect average consumption in a given year. Within-year variation in diets is an important concern that should be considered in the design and implementation of nutritional and other interventions relating to food consumption.

Use of non-standard measurement units

Food items are frequently purchased, exchanged, and consumed in quantities that respondents may not be able to easily estimate in terms of standard units of weight or volume. For example, a respondent will typically report consuming a bowl of porridge rather than a number in grams or millilitres. Efforts were made during the survey process to get the best possible estimates of these measures through discussion with respondents and the use of standardized visual aids, with auxiliary data also collected from local markets to enable the conversion of non-standard units to metric units. While these procedures reduce measurement error in quantities, some noise in estimates remains, and, for a small group of rarely consumed food items, it is not always possible to convert the reported amount into metric units. These conversion issues are discussed in greater detail in Bizikova et al. (2023).

Impact of extreme events

While our research approach considers gradual responses to climate change, the impact of extreme events such as droughts, floods, and heavy rainfall poses a serious challenge for analysed countries. For example, in Zambia, natural disasters, including droughts, floods, diseases, and pests (specific to certain regions) have affected the livelihoods of a significant number of people. Interventions included in our model indirectly contribute to increasing the resilience of farming households through improved food production, access to healthier food, and access to diverse agricultural inputs. However, analysis of the frequency and intensity of extreme weather events and their impact on these outcomes was beyond the scope of this project.

Institutional challenges

In practice, agricultural, food security and nutrition policy interventions can be delivered in a variety of ways that rely on different delivery mechanisms and supporting systems. This study includes information on income, seasonality in rates of undernourishment, gender and family status, and model factors such as access assets and caloric intake (Bizikova et al., 2023). Other factors that are also important in shaping effective interventions in this context include the use of formal and informal institutions, access to knowledge and physical infrastructure, as well as consideration of social, historical, and cultural conditions when promoting the interventions.

In our study, we consider the impact of food subsidies (e.g., food stamps) that can be delivered through universal unconditional cash transfer, depending on the country's context. Our model does not currently integrate an appraisal of institutions and delivery mechanisms that would likely speed up implementation or increase effectiveness. Yet, such delivery mechanisms are critical and often include agencies of central or regional governments (or other public or non-governmental entities) to ensure that, for example, a fertilizer subsidy reaches its intended beneficiaries. Future work should consider institutional preparedness and the effectiveness of delivery of interventions for more accurate estimates.

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The Zero Hunger Coalition catalyses coordinated action to achieve zero hunger in the world by 2030. An affiliate of HESAT2030, the Coalition unite a diverse range of stakeholders including 11 multilateral organizations, 27 civil society organizations and 30 countries.

www.zerohungercoalition.org/en

HESAT2030 is charting a course for policymakers and donors to make high-impact decisions and investments driven by data. Founding partners are the Food and Agriculture Organization of the United Nations (FAO), Shamba Centre for Food & Climate and CABI.

www.hesat2030.org