GCRFAFRICAP
CLIMATE SMART AGRICULTURAL DEVELOPMENT

Tanzania's Food System: A Scenarios Analysis

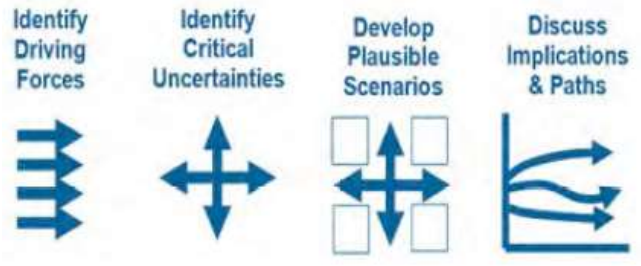
Executive Summary

The evolution of Tanzania's food system is critical to the country's development prospects over the coming decades. The population remains predominantly rural, rates of malnutrition are high and the agricultural sector provides a critical source of employment, income and export revenue. However considerable uncertainty surrounds the food system's future. Trends including demographics, climate change, environmental degradation, the development trajectories for domestic and international markets, rates of technological development and adoption, dietary patterns and social developments including the integration of a growing youth population into the job market and access to education and resources for women, all have important implications.

Taken together, these trends present huge uncertainty surrounding how Tanzania's food system will evolve between now and 2050. Any central estimate forecast of such a complex system over such a long time frame will certainly be wrong, and planning purely on the basis that 'expected' outcomes will materialize is likely to result in poor decisions. Instead, plans to develop Tanzania's agriculture and food system should explicitly recognize this uncertainty. Decision-makers should explore how choices and events might shape different futures and identify strategies that are resilient to uncertainty, i.e. 'no regret' options that should pay off in a range of possible futures, rather than the one we hope for or expect.

To help do so, a scenario exercise for Tanzania's food system was conducted with a selected group of stakeholders from government, academia, civil society and the agriculture sector (see Appendix for participant list). Through discussion, two critical driving forces, with *high uncertainty* regarding their outcomes, were selected from a shortlist of pertinent trends affecting the food system. These two critical uncertainties were used to create axes for a 2x2 matrix that frames four potential futures—one in each quadrant—reflecting more and less progressive outcomes for each critical uncertainty. Each one of these futures was then explored, allowing participants to consider the inherent uncertainty the future holds, and understand how choices, decisions and extraneous factors might contribute to very different outcomes.

The Steps in a Scenarios Exercise



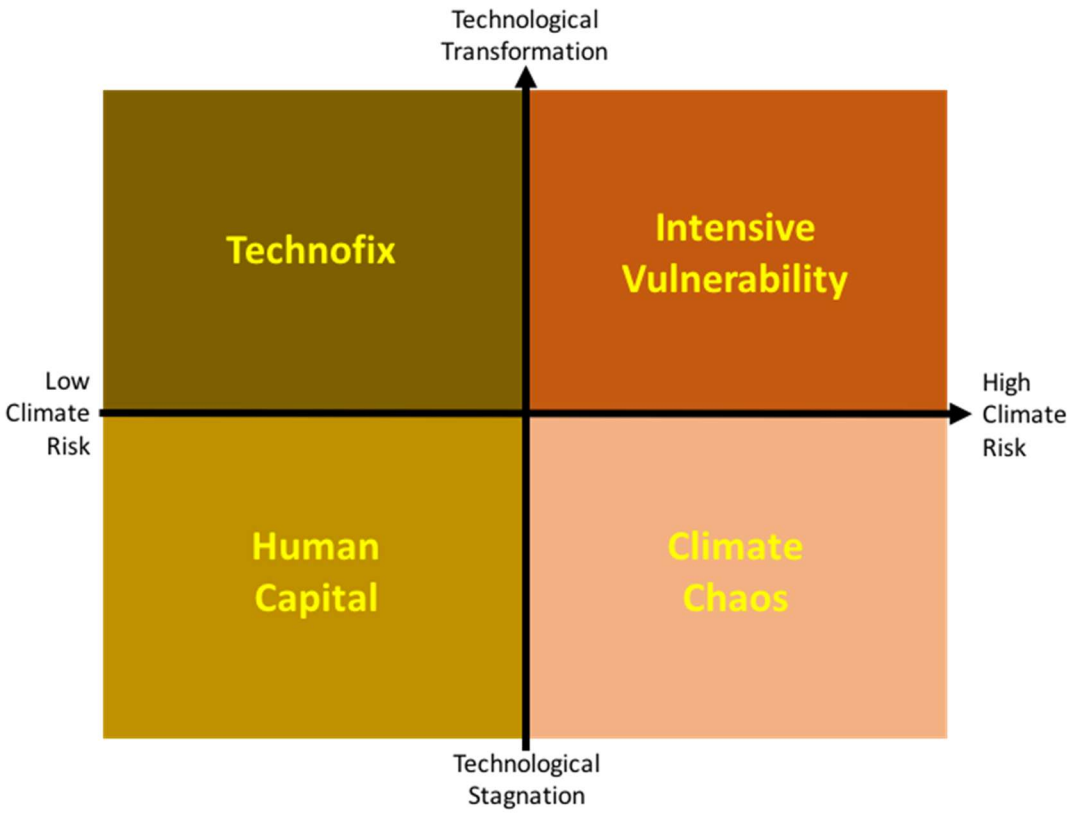
Results

The assembled experts chose the following two critical uncertainties to construct the scenarios matrix (market development was a close third):

1. **Technological Impact** relating to the extent to which technological change will shape the Tanzanian food system, through the development and adoption of new technologies and the impacts they will have on agriculture, food, processing, employment, markets, etcetera.
2. **Climate Risk** relating not only to the severity and frequency of climate change impacts, but also the exposure and vulnerability of agriculture and other food system components, actors and infrastructure.

This resulted in the scenario matrix below.

Tanzania Food System Scenario Matrix



Scenario 1: *Human Capital*
(Technological stagnation and low climate risk)
This scenario describes a future in which the technological situation in Tanzania has remained much like today, with Tanzanians responding to climate change through low-tech strategies to build resilience and human capital. New agricultural technologies have not been appropriate for sub-Saharan Africa, leaving farmers to adapt through traditional practices and with existing technologies. Agriculture remains a significant share of GDP and employment, with high rates of poverty. And whilst domestic food production remains relatively stable in the face of more climate extremes, low agricultural productivity and population growth means food imports have risen.

Scenario 2: *Technofix*
(Technological transformation and low climate risk)

In contrast, this scenario sees Tanzanian agriculture transformed by the development and adoption of pro-poor technologies, underpinned by substantial public Research and Development (R&D) and investment. Farmers have adopted new crop varieties with traits that increase resilience to climate change, whilst R&D for traditional and orphan crop varieties has helped increase crop diversity and dietary diversity. Supported by international climate finance, other technologies such as irrigation, early-warning systems and improved weather forecasting have been widely adopted. Increased yields have reduced tensions over land, helped stop deforestation and have supported reforestation in targeted areas whilst facilitating agricultural exports. Climate impacts have not been as pronounced as originally feared.

Scenario 3: *Intensive Vulnerability*
(Technological transformation and high climate risk)
In this scenario, rapid climate change has overwhelmed the pace of technological transformation, which has failed to reduce vulnerability. New technologies have focused on maximizing yield but at the expense of resilience, with crop yields becoming more volatile as a result. Where improved technologies have been available, cost has prevented poor farmers from accessing them and adopting them. The expansion of irrigation infrastructure has been poorly planned, leading to unsustainable water withdrawals and increased vulnerability to rainfall extremes. In parallel to smallholder agriculture, a large-scale, capital- and technology-intensive farming sector has emerged to supply export markets for cereals. However, this is now struggling as yields of maize and rice are declining due to high temperatures. Pastoralists and smallholder farmers have been hardest hit, resulting in high rates of rural-urban migration as they exit the rural sector in increasing numbers. Food imports are rising and a growing urban population is becoming increasingly reliant on nutritionally poor, processed foods.

Scenario 4: *Climate Chaos*
(Technological stagnation and high climate risk)
This is arguably the most troubling scenario, in which climate change has a devastating impact on Tanzania's farmers who lack the requisite technologies and practices to build resilience. The failure of the international community to reduce emissions has contributed to rapid climate change, whilst governments and donors have failed to make sufficient investments in adaptation. Frequent droughts lead to repeated food crises and the loss of livestock, resulting in high rates of poverty and undernutrition, and rapid rural-urban migration. Farmers and pastoralists have pursued increasingly short-term and unsustainable coping strategies – depleting soils and water resources and expanding into forests in search of more fertile land. Agricultural exports have collapsed and the country has become increasingly reliant on food imports and humanitarian food aid.

Overview of Tanzania's Food System

The evolution of Tanzania's food system over the coming decades is critical to the country's development prospects, including realizing Vision 2025 and the targets set out in national five-year development plans and the second phase of the Agricultural Sector Development Plan[1] (ASDP II), as well as Tanzania's contribution to the Sustainable Development Goals (SDGs).

Over two thirds of the population live in rural areas where livelihoods are heavily dependent on agriculture. Agriculture is estimated to employ 59% of the economically active population and constitutes approximately one-third of economic activity and export earnings.[2] Farms are predominantly small scale, with women constituting around half of the workforce but only 20% of landowners.[3] Agricultural growth has been slow compared to the industrial and services sectors, with productivity hampered by a familiar litany of challenges for developing country agriculture including low access to finance, technologies and inputs; rudimentary and often unsustainable farming practices; unproductive livestock; insecure land tenure; high rates of post-harvest loss; weak extension systems; and low-levels of investment and market development.[4] These challenges, and a high dependence on rainfed agriculture, make the sector particularly vulnerable to climate change.

As well as providing livelihoods and being an important driver of economic performance, the food system provides nutrition to a rapidly-growing population. Recent survey data indicate that undernutrition is widespread, and about one third of children under five are stunted.[5] This has implications for Tanzania's wider growth prospects, as undernutrition and stunting impair physical and cognitive development and suppress GDP growth.

GCRF-AFRICAP will work with Tanzanian stakeholders towards a food system that is **sustainable, productive, and climate smart** and able to meet the country's **food security** and **development** needs by 2050.

This is a major challenge. Numerous important trends will shape the evolution of Tanzania's food system. Many of these will be hard to predict and influence, creating considerable uncertainty. Below we briefly consider some of the most important.

Key trends

Tanzania is undergoing major demographic shifts. Fertility rates are high, contributing to rapid population growth and the prospect of a large demographic bulge of employment age. Whilst the population remains predominantly rural, it is becoming increasingly urban; ownership of agricultural land is becoming increasingly concentrated among the urban

[1] The United Republic of Tanzania (2016) 'Agricultural Sector Development Programme Phase Two (ASDPII).'

[2] CIAT; World Bank (2017) 'Climate-Smart Agriculture in Tanzania', CSA Country Profiles for Africa Series.

[3] Ibid.

[4] See, for example, The United Republic of Tanzania (2016) and CIAT; World Bank (2017).

[5] URT (2016) 'Tanzania Demographic and Health Survey 2015-16'.

middle class which in turn is driving consolidation of farms.[6] These trends have important implications for agriculture (who farms and how, if there is less labour in rural areas?), land ownership (who will own the land being farmed?) and nutrition, as urban diets tend to be more reliant on processed foods (they also tend to be higher in animal products, with potential implications for greenhouse gas emissions). What will the consumption habits of an increasingly urban population mean for Tanzania's food imports, which have historically been in balance with exports? Wheat imports are increasing – will urbanization drive increasing imports in other food categories? If so, will these be offset by growing exports in cash crops such as maize, rice, coffee, cashew nuts, cotton, oil seeds, fruits, horticultural produce (spices, vegetables)?

Urbanization and changing diets are also contributing to an increasing prevalence of overweight and obesity in Tanzania, complicating the picture of malnutrition. Whilst problems of underweight and stunting remain, more than a quarter of people are now overweight or obese. How will these trends evolve over the coming decades? Will Tanzania's population enjoy nutritious and diverse diets in 2050, or will diets become less diverse with nutrition provided by fortification?

Tanzania has a high fertility rate and fast population growth which will increase demands upon the food system. As growing numbers of women and men approach working age, how many will find livelihoods in agriculture, which may become more capital, and less labour, intensive? In this context, what might the prospects be for peri-urban agriculture? Can young people be tempted to remain in agriculture if the opportunities can be created for them? And can women, who already account for half of the agricultural workforce, be provided with better access to education, skills, technologies and land?

Tanzania's economic growth holds major implications for the food system. The country has achieved strong growth over the last 15 years, averaging just under 7% annually. The sustainable rate of future growth and how this is distributed will have important impacts on income inequality, poverty and job creation and consequently people's ability to afford food. The government has prioritized certain sectors including automotives, hydrocarbons and chemicals, and construction. Will these new sectors create enough manufacturing and services jobs to deal with increasing rural-urban migration and growing numbers of young people reaching employment age? Will sluggish agricultural growth be addressed, creating new opportunities for value addition through agro-processing? Will new infrastructure and supply chain linkages help to address pervasive post-harvest losses? Organic agriculture may provide new market opportunities if Tanzanian farmers can integrate into supply chains and meet the standards required.

Tanzania has some geoeconomic advantages in these respects. It has a long coastline in a region with many landlocked countries, providing it with an opportunity to develop regional supply chains and capture value-addition in the form of agro-processing and other industrial activities. Foreign direct investment (FDI), regional trade relationships and developments in international markets will influence the extent to which Tanzania can exploit these

[6] Jayne et al (2016) 'Africa's changing farm size distribution patterns: the rise of medium-scale farms', *Agricultural Economics*, 47.

advantages. Regional trade relationships will be shaped by politics and developments among Tanzania's neighbours, whilst international markets will be subject to even greater uncertainties. Commodity markets are likely to become more uncertain due to climate change, which will affect demand for, and investment in, hydrocarbons, whilst the increasing incidence and severity of extreme weather will increase agricultural market volatility. Growing protectionism among industrialized and developing economies may increase as new technologies such as automation and artificial intelligence reduce manufacturing jobs. These same technologies may also reduce the opportunities for manufacturing-led growth in countries with abundant low-wage labour such as Tanzania, whilst there is growing uncertainty as to whether manufacturing jobs will migrate from China to low-income countries in the manner of previous waves of industrialization.[7]

A number of environmental trends have important implications for Tanzania's food system. First, land and water. Arable land per capita is by no means low in global terms, but only about one-third is cultivated.[8] Technological constraints—in particular a lack of irrigation infrastructure—and a lack of financial and human capital effectively limit farming to a much smaller area. Protected areas may add further constraints. In many instances, unsustainable agricultural practices have contributed to land degradation and deforestation.

Land availability is further constrained by Tanzania's extensive use of protected areas – critical for maintaining biodiversity and supporting the country's growing tourism sector, creating tensions with agriculture. In this context, tensions over land and water may arise *within* agriculture between pastoralists and sedentary farmers, and increasingly between urban and rural users as urbanization and industrialization create new demands for land and water. Dietary trends and plans to increase exports of cash crops mean production of water-intensive crops such as maize, sugarcane and rice is likely to increase, whilst growing consumption of animal products will likely add to demand for land and water.

Climate change exacerbates these challenges. Rising temperatures are expected to slow yield growth and are a major threat to production of maize and rice for example. Uncertainty around how rainfall is likely to be affected across Tanzania creates major challenges for adaptation: whilst extremes of drought and intense precipitation are expected to increase, there is less confidence about how average rainfall will change and how different regions will be affected. Whilst expansion of irrigation presents an obvious adaptation opportunity, there is an attendant risk of maladaptation should poor planning result in unsustainable withdrawals or create unmanageable competition for water with other users.

Will agriculture in Tanzania achieve sustainable intensification, helping to alleviate increasing tensions over land and water, reduce poverty, improve food and nutritional security, whilst minimizing further environmental degradation from fertilizer and pesticide use? What role can plant-breeding, Information and Communications Technology (ICT) and more advanced technologies such as remote sensing and precision agriculture play? Are

[7] 'The pathway to economic development is growing more treacherous, again', *The Economist*, Nov 3rd 2018.

[8] Tanzania's arable land per capita is 0.25 hectares per person, compared to a global average of less than 0.2, however above average population growth means this is likely to deteriorate. Of 44 million hectares of arable land, 33% is in cultivation. See World Bank Development Indicators.

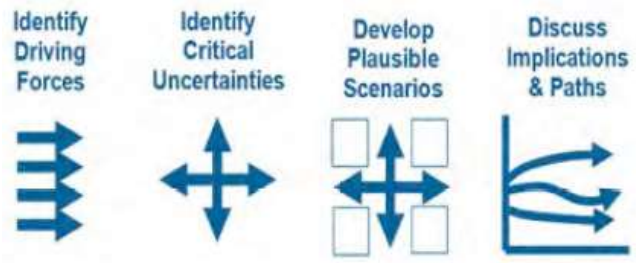
there opportunities for leapfrogging up the technology ladder? Will degraded lands be restored? How will climate change affect Tanzanian agriculture, and will sufficient resources and technologies be available for farmers to adapt? Will future demand and/or markets align with current investment in agricultural development?

The scenarios approach

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

A scenario exercise can help with planning for uncertainty by exploring the range of possibilities that the future may hold. In such a process, a group of participants identifies a set of driving forces that will shape future outcomes over the period in question. Through discussion, two impactful trends (or critical uncertainties) are selected over which there is *high uncertainty*, thus maximizing the range of possible future outcomes. Ideally these should also be as independent as possible in order to maximize the extent of future possibilities. These are used to create a 2x2 matrix that frames four potential futures—one in each quadrant (see figure 1 below). Each one of these futures is then explored, creating a rich, narrative-driven scenario into which the other (discarded) driving forces can be integrated. Exploring these four scenarios through discussion allows participants to better embrace the inherent uncertainty the future holds, and understand how choices, decisions and extraneous factors might contribute to very different outcomes.

Figure 1: The Steps in a Scenarios Exercise



Identifying the most critical uncertainties

Whilst all of the trends considered above are clearly important in determining whether or not Tanzania's food system in 2050 will be sustainable, productive and climate smart, they vary in terms of their uncertainty. For example, whilst temperature and rainfall changes due to climate change are both important, there is considerably more uncertainty about the latter. And whilst there may be some uncertainty about the extent of population growth

and urbanization that will occur, there is little doubt that both will increase significantly and that plans should be made on this basis.

Participants identified and discussed the following shortlist of important uncertainties for Tanzania:

Diets and Nutrition	• How will the nutrition transition play out in Tanzania? Will traditional diets and foods be preserved, or will western diets and processed foods be adopted? Will diets be diverse and nutritional? • How will food safety evolve? • How will the nature of malnutrition evolve among different sections of society?
Human Capital	• How will education affect food system outcomes? • Will efforts to address gender inequality be successful? • What will a more equal society mean for human capital and food security? • How will a growing youth population be accommodated and employed? • How will urbanization affect farming, human capital and social inclusion?
Information and Technology	• Will information, training and extension services be appropriate and sufficient? • What will be the impacts of future technologies? Will they be affordable and accessible? Will farmers want to adopt them? Will technologies help farmers adapt to and/or mitigate climate change? • How will they affect farm size and agricultural employment?
Gender and Youth	• Will agricultural development, finance, technology and food markets be inclusive? • How could more inclusive markets affect food security outcomes and the development of the agriculture sector?
Market Development	• Will physical infrastructure (e.g. storage, roads and transport) be developed at sufficient speed and scale? • Will soft infrastructure (information, regulations, transparency) be developed effectively? • How will supply chains organize for export, transit and domestic supply? Will opportunities for value addition and agro-processing be realized? • How will international commodity markets evolve and what will be the implications for imports and exports? • How will markets facilitate or limit fair prices for farmers, and the dissemination of new technologies and improved practices?

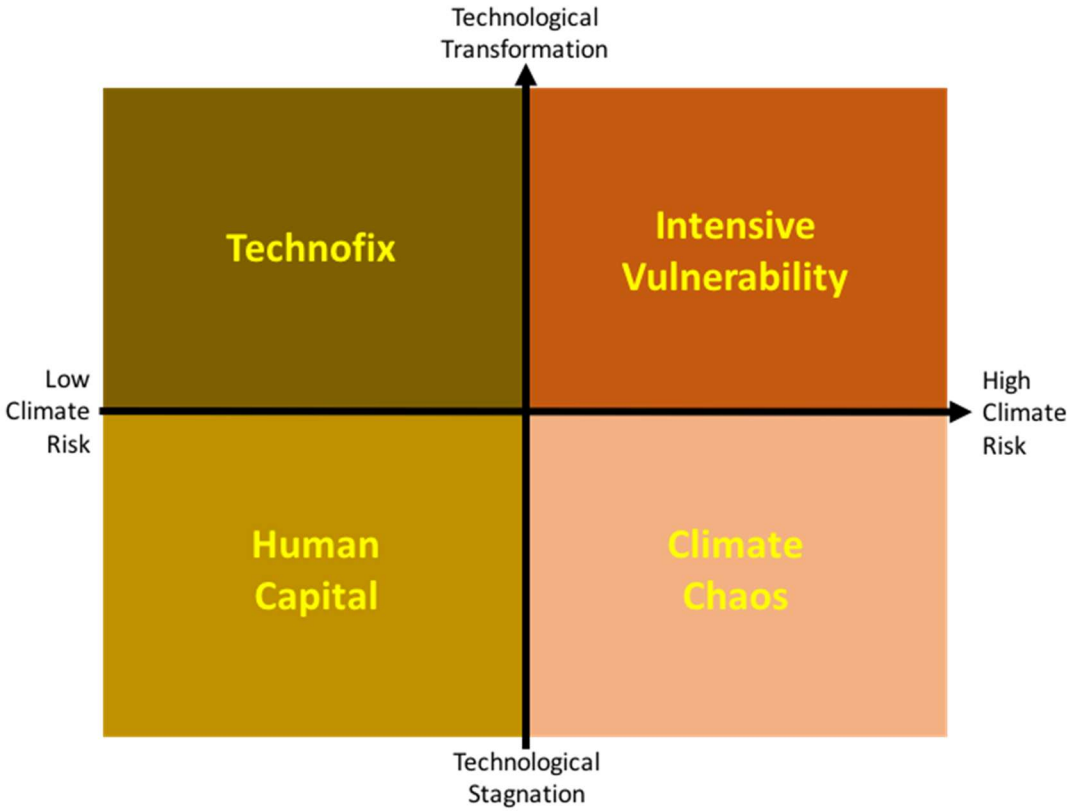
	• What will the role of the private sector be, who will investors be (urban elite / international citizens), and what will they invest in (production, processing, trade)?
Climate Risk	• How will climate change affect different regions of Tanzania? • How will precipitation patterns and extremes change? • Will adaptation efforts be effective in the face of such uncertainty? • Will international efforts to address climate change be successful? • Will different sections of society be more/less vulnerable to climate change?
Environmental Change	• How will climate change affect soils, forests and water availability? • How will use of land and natural resources change and what are the implications of this? • How will land use, natural resource degradation and water scarcity be governed and managed? • Will people move to climatically less sensitive / more favourable areas, and what will be the impacts? • Will farming practices become more sustainable? • Will the risks from pests and disease change?

The assembled experts chose the following critical uncertainties to construct the scenarios matrix:

1. **Technological Impact** relating to the extent to which technological change shapes the Tanzanian food system, through the development and adoption of new technologies and the impacts they have on agriculture, food, processing, employment, markets and so forth.
2. **Climate Risk** relating not only to the severity and frequency of climate change impacts, but also the exposure and vulnerability of agriculture and other food system actors and infrastructure.

Market development was a close third. This resulted in the scenario matrix below.

Figure 2: Tanzania Food System Scenario Matrix



The four scenarios are explored below, starting in the bottom left quadrant.

Scenario 1: *Human Capital* (Technological stagnation and low climate risk)

Scenario Description

In this scenario, the technological situation in Tanzania has remained much like today. Large sections of Tanzanian society remain poor. Agriculture still accounts for a significant share of GDP and employment, and is characterized by labour-intensive farming. A lack of appropriate technologies means post-harvest losses still hamper food availability. Traditional crop varieties have attracted minimal investment in plant-breeding and crop improvement and productivity remains low; new varieties are not adopted by farmers. Farming has remained labour intensive whilst demand for food has risen with a growing population. As a consequence, the agricultural workforce has remained large, rural-urban migration has not been as significant as many predicted and the urban population stabilized earlier than expected. A large peri-urban farming sector has emerged.

Low yields and continued rapid population increase mean that crop area has expanded as domestic demand for food has risen. Tensions over land between farmers and pastoralists,

local elites and investors, and agriculture and tourism have increased as a result and forest cover has declined.

The effects of climate change have become more pronounced in Tanzania, but worst case impacts have not transpired. In a context of limited irrigation, higher temperatures have suppressed yield growth of cereals, but farmers have been supported by government to adapt to climate change using traditional knowledge and low-tech solutions to manage yield variability. This includes the increasing use of traditional drought-resistant crops such as cassava, sorghum and millet in place of, for example, maize, and diversification towards cash crops for sale in local markets as a means of income generation. Human capital among farmers has been built through improved knowledge and skills, a focus on women, and the development of community networks and cooperative structures that allow farmers to pool risk.

Domestic food production is diverse and stable but is insufficient to meet demand, and, as a consequence, food imports have risen. Undernutrition remains a serious public health issue, particularly in rural areas where subsistence farming dominates.

How did we get here?
New agricultural technologies were neither adapted nor appropriate for sub-Saharan Africa. For example, popular opposition in Africa to genetic modification quickly extended to gene-editing, dissuading investors and philanthropic funders from developing new plant varieties for African markets. Meanwhile the development of precision farming, robotics and remote sensing technologies accelerated at the global scale, but focused on applications in large-scale industrial farming systems. International food markets continued to be supplied by existing breadbasket regions in North and South America, Europe and the Black Sea with little international investment flowing to African agriculture.

Faced with a lack of private investment and access to technology through markets, Tanzania adapted to climate change through climate-smart farming practices and the widespread adoption of readily-available technologies and indigenous knowledge. The government invested heavily in building knowledge and expertise among farmers through training and extension services, with a special focus on youth and women. Capacity building emphasized agricultural diversity as a resilience strategy: livestock farmers adopted new animal varieties as a risk diversification strategy whilst sedentary farmers diversified their crop mix. Peri-urban agriculture helped keep the costs of extension services down and kept domestic supply chains short.

At the international level, increasingly severe climate impacts led governments to increase the ambition of their climate pledges, however the same ambition was not applied to climate finance, which failed to reach the $100 billion pa by 2020 pledged at Copenhagen and has stagnated. As a result, there has been minimal international grant funding for adaptation in developing countries.

Early signs that could signal a shift to this reality:

- **Significant increase in Nationally Determined Contribution (NDC) ambition at UNFCCC in 2020 and 2025.**

- **Overall GDP and agricultural productivity growth slow** due to a lack of access to productivity enhancing technologies.

- **Early climate change data show global temperature increases not as bad as "worst case" projections.**

- **The urbanization rate slows faster than predicted** as slow productivity growth in agriculture results in fewer people exiting the sector.

- **FDI in the agricultural sector stagnates or declines** resulting in reduced access to private technologies and investment.

- **Increasing food imports** as domestic agriculture struggles to keep pace with demand.

- **The prevalence of undernourishment begins to increase again** as food demand starts to exceed domestic food supply growth whilst a weaker economy reduces foreign exchange for food imports.

- **Improved soil health and reduced water scarcity** due to the adoption of sustainable farming practices, however **deforestation increases** due to the expansion of agriculture.

Scenario 2: *Technofix*
(Technological transformation and low climate risk)

Scenario Description
In this scenario, Tanzanian agriculture has been transformed by the development and adoption of pro-poor technologies, underpinned by substantial public R&D investment. Farmers have adopted new crop varieties with traits that increase resilience to climate change, whilst R&D for traditional and orphan crop varieties has helped increase crop diversity and dietary diversity. Expansion of irrigation has been well planned and coordinated. Integrated Pest Management has been developed to deal with existing and emergent biotic stresses. Agricultural productivity has increased, facilitating exports and enhancing domestic food security; falling labour-intensity of agriculture and larger farm sizes due to technological returns to scale have contributed to faster rural-urban migration. Increased yields per hectare have reduced tensions over land and helped stop deforestation and support reforestation in targeted areas. Climate impacts have not been as pronounced as originally feared.

In urban areas, Tanzania has successfully leapfrogged up the technology ladder, adopting clean energy technologies and advanced manufacturing and automation technology that

have underpinned an increase in in-country processing and value addition, strong GDP growth and improved resource efficiency. Faster GDP growth has attracted increased foreign investment, contributing to a virtuous circle of investment and productivity growth. Skilled workers have benefited in industrial and agricultural sectors, however unskilled workers have struggled to find work, leading to further urbanization of the population.

How did we get here?
Following the UN Secretary General's summit in 2019, governments agreed to increase their pledges to reduce emissions, resulting in a global peak in emissions by the mid-2020s. A number of countries with domestic carbon prices, including China and the European Union, committed to form a free-trade carbon-pricing area protected by border tariffs. As a result, a growing number of other countries began to implement carbon prices to be able to export to these protected markets. By 2020, developed countries were mobilizing $100 billion of climate finance, with half going to adaptation in developing countries.

A number of donors and philanthropic foundations collaborated with African governments to develop high-tech, high-yielding and climate-resilient varieties of orphan crops that became available throughout the 2020s and 2030s. Government strategies to attract foreign investment in the agricultural and manufacturing sectors paid off, with special economic zones and industrial parks attracting significant inward investment, enabling the creation of backward linkages to the rest of the economy and the transfer of new technologies.

Early signs that could signal a shift to this reality:

- **At the UNFCCC in 2020, governments increase the ambition of national climate change targets and mobilize $100 billion pa of climate finance** reducing global emissions and increasing the resources available for adaptation.
- **Increases in public R&D for agricultural technology from governments, donors and foundations.**
- **Sustained GDP growth and increasing agricultural productivity in Tanzania.**
- **Increasing FDI in manufacturing and agriculture.**
- **Reduced rates of deforestation.**

Scenario 3: *Intensive Vulnerability* (Technological transformation and high climate risk)

Scenario Description
In this scenario, technological transformation has failed to reduce the vulnerability of agriculture to rapid climate change. Technologies have focused on maximizing yield but at the expense of resilience, with crop yields becoming more volatile as a result. Improved green technologies have been developed but in many cases access to these technologies is

insufficient, leading to climate risk being high for the majority of farmers. The rapid expansion of irrigation infrastructure has led to maladaptation, placing agriculture into direct competition with urban and industrial users and leading to unsustainable water withdrawals.

New technologies have been developed by the private sector and been deployed through the market, so have remained inaccessible to poor smallholder farmers. The result has been a two-tier agricultural sector in which large farms supplying export markets have access to new, advanced technologies, whilst poor subsistence farmers remain reliant on outdated technologies. Public finance for adaptation has been limited, resulting in a lack of pro-poor technologies and public goods such as early warning systems and weather forecasts. However, even the large high-tech farms are struggling—intensification of agriculture has helped to some extent but has failed to completely offset losses from increased yield variability. Yields of staple crops such as maize and rice are declining due to high temperatures. Rainfall variability has increased markedly, creating frequent problems of 'too much' and 'too little' water. As a result of this increased climate variability the intensity of pest and disease outbreaks has also increased. Integrated Pest Management has helped some larger agribusinesses deal with these outbreaks but smallholders have suffered.

Pastoralists have been hardest hit. They have lost access to land as large-scale farming systems have expanded and have become more vulnerable to climate change due to the increasingly extreme weather and reduced options for movement.

Rates of rural-urban migration are very high as pastoralists and subsistence farmers exit the rural sector in increasing numbers—those farmers that remain on the land are highly skilled and work on the large export-oriented farms.

High demand for food from a large urban population has not been met by Tanzania's two-tier agricultural sector; the first tier exports cereals onto international markets and the second tier is largely subsistence farming. As a result, food imports have increased significantly and diets have become more reliant on processed foods. Levels of obesity and proportion of the population overweight have increased.

How did we get here?

At the international level, governments failed to deliver on the Paris Agreement. Pledges to cut emissions were only partially fulfilled and countries failed to increase the ambition of pledges at the rate needed, with the result that global emissions did not peak until well into the 2030s. Pledges to deliver climate finance were also unfulfilled, depriving developing country governments of the resources needed to finance adaptation on the scale needed.

In Tanzania, government efforts to attract private investment into the agricultural sector were successful, resulting in the emergence of large farming systems and export supply chains. However relatively little attention was paid to governance of land and water, resulting in uncoordinated irrigation investments and tensions over access to land.

An increasing focus on big business led to excessive deregulation that neglected the accumulation of social capital and protection of natural capital in favour of attracting private capital. Profit came at the expense of nutrition security and human development.

Early signs that could signal a shift to this reality:

- **No meaningful increase in NDC ambition at UNFCCC for 2020 COP or 2025 COP and governments fail to mobilize $100 billion pa of climate finance by 2020** with the result that international momentum is lost and future financing pledges decline.
- **Increasing FDI in agriculture focused on export agriculture and large-scale farms.**
- **Sustained or increasing rates of GDP growth** (at the expense of natural and social capital).
- **Increasing food imports.**
- **Increasing rates of rural-urban migration.**
- **Increasing prevalence of obesity and overweight.**
- **Changes in rainfall variability at upper end of predictions.**

Scenario 4: Climate Chaos (Technological stagnation and high climate risk)

Scenario Description

In this scenario, climate change is having a devastating impact on Tanzania's food system. Frequent droughts are leading to repeated food crises and the loss of livestock. The spread of pests and disease in the crop and livestock sectors is rapid and unable to be combated by traditional technologies. Rural-urban migration is high as vulnerable farmers and pastoralists exit the agricultural sector in search of more secure livelihoods, creating high levels of unemployment and social tensions in cities. Poverty and undernutrition are high.

In rural areas, the environment has been degraded as farmers and pastoralists have pursued increasingly short-term and unsustainable coping strategies—depleting soils and water resources and expanding into forests in search of more fertile land. The farming system is heavily reliant on present-day pesticides and fertilizers, but as these are costly and unsustainable they exacerbate the depletion of resources. Conflicts over access to land and water intensify, contributing to local migration and population movement. Food crises have become common. Agricultural investment is low due to the high climate risk and a farming sector that has exhausted its capital coping with crop failure after crop failure.

The collapse of the agricultural sector has undermined the government's revenue base and reduced its foreign exchange earnings. Tanzania has become ever more reliant on food imports and humanitarian aid, but these have become increasingly volatile due to extreme weather disrupting international food markets, leading to frequent price spikes and import shortfalls. Food prices have increased. The presence of development practitioners, consultants and humanitarian workers in Tanzania has increased.

How did we get here?

The critical factors leading to this outcome were a lack of timely international action to reduce emissions and mitigate climate change; a lack of effective policy and financial support from the public sector; and failures in agricultural development assistance, with poorly-designed interventions insufficiently informed by realities on the ground. Insufficient public finance was directed to R&D in pro-poor technologies for Tanzanian farmers, whilst government and donors also failed to invest in research to inform adaptation strategies for the rural sector. As a result, farmers and pastoralists were left without the access to finance, technologies or knowledge needed to adapt to a rapidly-changing climate.

Rapid climate change also hampered government attempts to attract foreign investment in the agricultural sector. As the speed and extent of climate change in Tanzania became apparent, investors chose instead to invest in less risky countries, with less pronounced climate change, better infrastructure and more developed markets.

Early signs that could signal a shift to this reality:

- **Decreasing crop production, decreasing livestock population.**
- **Increasing food prices.**
- **Increasing food imports.**
- **Increasing rates of rural-rural and rural-urban migration.**
- **Increasing rates of undernutrition.**
- **Stagnant agricultural productivity and investment.**
- **Changes in rainfall variability at upper end of predictions.**
- **Increased humanitarian assistance/food aid.**

Implications of the Scenarios

None of these scenarios are impossible. Many of the early signals that presage them can be observed today. Public resources for investment in agriculture and adaptation are currently insufficient to meet needs in developing countries. The effects of climate change appear to

be occurring faster and more powerfully than predicted. Although global progress to reduce greenhouse gas emissions is increasing, there is little sign that the international community will achieve the kinds of reductions needed to avoid the worst climate impacts. In Tanzania, there are already tensions over access to land and water and early data indicate that rainfall variability is increasing.

Looking across the scenarios, the following insights emerge:

1. The extent and nature of private sector investment will be fundamental to the evolution of Tanzania's food system. Private sector investment has implications for technology diffusion, and the types of technologies that are accessible. It may also influence the mix of crops grown and the markets they are grown for, and the livelihood opportunities for farmers and agricultural labourers. Tanzanian farmers are also part of the private sector, and their ability to invest and the choices they make about what to invest in are equally important. Outcomes will be dependent on the answers to a number of critical questions about the nature of investment: Which financial support mechanisms? Which technologies and crops? What farming systems and practices? Which markets?

2. Public support for the agricultural sector and climate change adaptation is critical. The Tanzanian government has significant agency in shaping private investment decisions, for example through the use of public finance and by supporting R&D for adaptation and pro-poor technologies. The provision of donor assistance and climate finance can provide additional resources for government strategies, but these typically come with conditions and will not be sufficient alone.

3. The evolution of the agricultural sector and agricultural markets could hold important implications for Tanzania's nutrition transition. If agriculture provides a diverse food supply to domestic markets, then this can help ensure nutritional diversity and reduce the need for imports. If agriculture evolves to supply export markets, or fails to keep pace with domestic demand, then food imports, potentially of processed foods for urban consumers, will increase. How climate change affects Tanzania will also play a role here. For example, under certain climate scenarios, it may make sense for Tanzania to stop producing certain crops and maintain nutritional diversity through trade: by importing these crops from regions with more suitable climates whilst focusing domestic production on more resilient varieties.

4. The speed at which climate change affects Tanzania and the extent of disruption to weather patterns will affect not only the ability of Tanzanian farmers and pastoralists to adapt, but it will also influence private investment decisions. Faced with increasing risk, farmers and businesses may choose not to invest. In the absence of effective adaptation, farmers may also be forced into unsustainable coping strategies that could deplete soils and increase tensions over land and water resources. Early adaptation, informed by sound research and evidence, will be key.