

The future of food security, environments and livelihoods in Eastern Africa: four socio-economic scenarios

Working Paper No. 63

CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS)

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RESEARCH PROGRAM ON
**Climate Change,
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Abstract

This report presents 4 scenarios for the future of food security, agriculture, livelihoods and environments in East Africa. These scenarios were developed by the CGIAR Research Program on Climate Change, Agriculture and Food Security in collaboration with a wide range of regional stakeholders. The report discusses the theory and development process of the scenarios, then presents detailed scenario narratives, semi-quantitative assumptions for a range of indicators, and finally outputs generated by 2 agricultural economic models, IMPACT and GLOBIOM. The report goes on to discuss the key results from the scenarios and then to describe the use of the scenarios in processes to guide decision-making in the context of East African food security and climate adaptation.

Keywords

Scenarios; Food Security; Agriculture; Climate Change; East Africa

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Acronyms

ASARECA	Association for Strengthening Agricultural Research in Eastern and Central Africa
CARE	Cooperative for Assistance and Relief Everywhere
CCAFS	Research Program on Climate Change, Agriculture and Food Security
CGIAR	(Former) Consultative Group on International Agricultural Research
COMESA	Common Market for Eastern and Southern Africa
CSO	civil society organization
EAC	East African Community
EAAF	East African Farmers' Federation
EHPEA	Ethiopian Horticulture Producer Exporters Association
EU	European Union
FAO	United Nations Food and Agriculture Organization
GDP	gross domestic product
GFAR	Global Forum on Agricultural Research
GHG	greenhouse gas
GLOBIOM	Global Biosphere Management Model
IFPRI	International Food Policy Research Institute
IGAD	Intergovernmental Authority on Development
IIASA	International Institute for Applied Systems Analysis
IMPACT	International Model for Policy Analysis of Agricultural Commodities and Trade
IPCC	Intergovernmental Panel on Climate Change
LUC	land-use change
NEPAD	New Partnership for African Development
NGO	Non-Governmental Organization
REDD	Reducing Emissions from Deforestation and Forest Degradation
SIA	Systemic Integrated Adaptation
SID	Society for International Development
SSP	shared socio-economic pathways
UNFCCC	United Nations Framework Convention on Climate Change
USD	United States Dollar
WFP	World Food Programme
WTO	World Trade Organization

Introduction

Researchers, policy makers, entrepreneurs and development practitioners working to improve food security, environmental health and rural livelihoods in the developing world face many uncertainties when exploring the future of food systems (Ericksen et al. 2009). It is difficult to predict what economic, political and social conditions will be like in the next few years and virtually impossible to predict the medium to longer term (Van Vuuren et al. 2012). Climate change and variability are among the greatest unknowns, and are likely to have far-reaching effects on food security, environments and livelihoods (Vermeulen et al. 2012).

This working paper presents 4 alternative plausible futures, or scenarios, for food security, environments and livelihoods in Eastern Africa. The scenarios are based on different assumptions and pathways of socio-economic and political development. They were developed under the auspices of CGIAR's Research Program on Climate Change, Agriculture and Food Security (CCAFS) (see Box 1). A number of workshops, attended by stakeholders, drawn from governments, civil society, the research community and the media, fed into the development process. Written as if the year is now 2030, the scenarios describe trends and events since 2010. These scenarios were translated to semi-quantitative assessments of a range of drivers and indicators and quantified with 2 agricultural economic models, the International Model for Policy Analysis of Agricultural Commodities and Trade (IMPACT) (Rosegrant et al. 1995), developed by the International Food Policy Research Institute (IFPRI) and the Global Biosphere Management Model (GLOBIOM) (Havlik et al. 2011), developed by the International Institute for Applied Systems Analysis (IIASA). The separate presentation of the semi-quantitative and quantitative results in this report allows the stories to flow and also makes it easier for the reader to compare data between the different scenarios.

Box 1: The CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS)

CCAFS is a major research partnership between CGIAR and the global environmental change community. Its objectives are:

- To close critical gaps in the knowledge of how to enhance – and manage the trade-offs among – food security, livelihood and environmental goals in the face of a changing climate.
- To develop and evaluate options for adapting to a changing climate and to inform agricultural development, food security and donor investment strategies and policies.
- To enable and assist farmers, policy makers, researchers and donors to continually monitor, assess and adjust their actions in response to observed and anticipated changes in climate.

The CCAFS target regions are Eastern Africa, Western Africa, South Asia, Southeast Asia and Latin America. Within East Africa, CCAFS focuses on Ethiopia, Kenya, Tanzania and Uganda, but the model results of the scenarios process include a broader regional scope and also include Rwanda and Burundi to make the scenarios useful in the entire Eastern African region and for the Eastern African community specifically. The CCAFS scenarios have been, and are, used to aid policy development, investment guidance, institutional change, the testing of interventions and guidance for research directions.

The aim of the scenarios process has been to provide alternate, plausible, relevant and challenging futures in narratives and numbers that can be used by policymakers, the private sector, civil society leaders and development researchers to test ideas about the future and the strategies, technologies and research recommendations needed to deal with the future successfully. Specifically, the scenarios can guide policy prioritization, frame research questions and help agenda setting in the drive towards improved food security, environmental management and rural livelihoods in the face of climate change in Eastern Africa.

What are scenarios and why are they useful?

Scenarios are different ‘what if?’ accounts of the future (Van Notten et al. 2003). They are not predictions, but instead should help decision makers and researchers acknowledge future uncertainty and explore the dynamics of different but plausible future worlds (Wilkinson and Eidinow 2008). Scenarios guide the consideration of future uncertainties without getting lost in the multitude of possibilities. They present individual stories that combine very different perspectives and types of information, bringing diverse futures to life in the process (Kok et al. 2006a).

The process of developing and using scenarios brings decision makers together to explore and then plan for future socio-economic and environmental uncertainties. Scenarios explore the assumptions of diverse stakeholders about their context and the future, and make those assumptions explicit. This clarifies the thinking of different actors and allows them to interact, learn together and build partnerships for shared action while allowing them to plan beyond the normal sphere of otherwise largely unexamined and unchallenged ideas about the future.

Using scenarios for testing strategies and setting agendas ensures that options are considered under several futures. Figure 1: Rather than providing a single ‘most likely’ forecast, multiple scenarios explore multiple concrete, plausible futures and what these would mean for food security, environments and livelihoods. This way, the set of scenarios engages with broad future uncertainty for the testing of policies, investments and research innovations. Figure adapted from Bourgeois et al. (2012) shows that scenarios go beyond forecasting, not attempting provide a single most likely future, but instead exploring different, plausible, future pathways. This way, scenarios help to stretch ideas about possible futures while stimulating consistent thinking about each potential future world (Schoemaker 1993). This process throws light on which options are feasible under all futures and can be considered ‘no regrets’ options, which options are not feasible under any future, and which are preferable under only one or a few futures and should be considered only in specific circumstances (Kok et al. 2011). Importantly, scenarios as used in the CCAFS programme are not themselves about a decision maker’s choices, but instead about contextual factors that decision makers cannot directly influence and how these factors affect decision spaces (see Figure 2).

In contexts where many diverse groups of people interact, scenarios reveal the development potential that can be released by linking knowledge and action among groups and across system boundaries, and developing a shared language about the future (Van der Heijden 2005). Consulting diverse stakeholders ensures that a wide range of knowledge and experience is brought to the table, while all involved are able to explore the implications of the scenarios for their own decision-making environments (Wilkinson and Eidinow 2008).

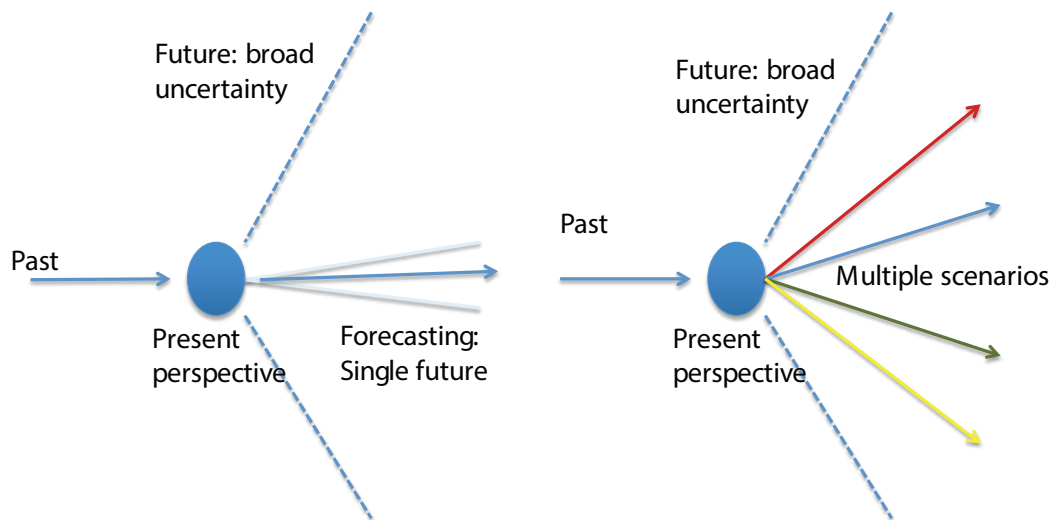


Figure 1. Rather than providing a single ‘most likely’ forecast, multiple scenarios explore multiple concrete, plausible futures and what these would mean for food security, environments and livelihoods. This way, the set of scenarios engages with broad future uncertainty for the testing of policies, investments and research innovations. Figure adapted from Bourgeois et al. (2012).

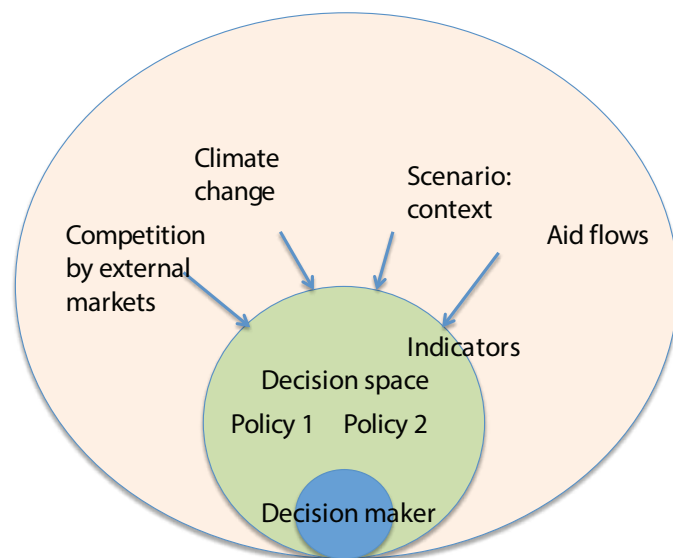


Figure 2. Scenarios as used by CCAFS focus on the context for decision making – those drivers of change that are outside of the control of decision makers, such as climate change and large-scale socio-economic drivers. The scenarios then explore what changes in these drivers mean for issues that fall within the decision space of a decision maker or group, such as rural poverty levels or crop yields. Adapted from Emery and Trist (1965, 2008).

Scenarios in the CGIAR Research Program on Climate Change, Agriculture and Food Security

CCAFS is coordinating regional scenario development and application in East Africa, West Africa, South Asia, Southeast Asia, Central America and the Andean region. In each region it is working with stakeholders from the policy, private, media and research sectors as well as non-government and civil society organizations (CSOs). The scenarios build on previous work done by the CCAFS team and its Scenarios Advisory Group, in particular the multi-level scenarios work conducted as part of the Millennium Ecosystems Assessment (2005).

The CCAFS regional scenarios process plays a unique role in the context of food security, environments and livelihoods. It helps to articulate the challenges presented by climate change by introducing a complementary focus on socio-economic and governance change. At the same time, by adopting a regional rather than a purely national stance, the scenarios process links different scales and integrates the needs of a wide range of stakeholders, thereby identifying potential synergies and trade-offs (Eriksen et al. 2009). A cross-level, cross-sector approach of this kind that focuses on exploring different futures with partnerships across food systems has seldom been attempted previously (Zurek and Henrichs 2007).

Figure 3 shows the different phases of the process, starting with development of the scenarios, then their elaboration through modelling and discussion with stakeholders (including the media), and finally their application in strategic planning, visioning and strategy testing. The scenarios can be applied in many contexts and their use provides feedback that can inform, improve and enrich their content.

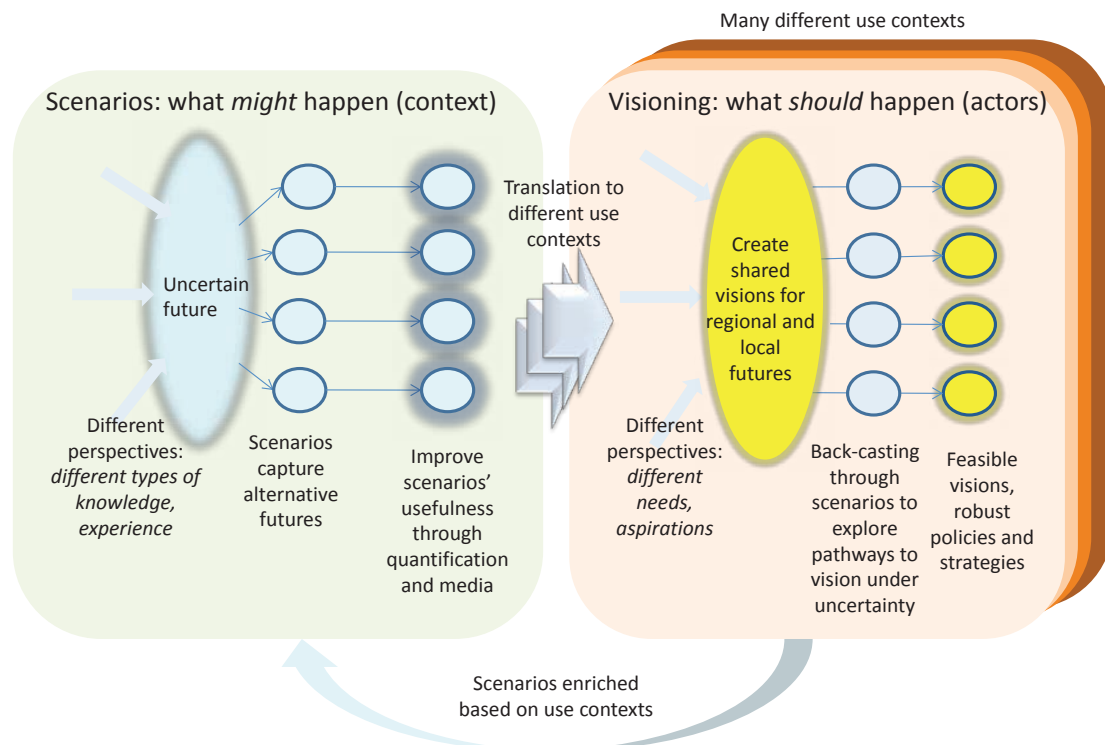


Figure 3. The phases of development and use of scenarios in the CCAFS programme.

The CCAFS Eastern Africa scenarios and their development

The CCAFS scenarios for Eastern Africa were developed in 2010 and 2011 at 4 workshops attended by a range of stakeholders from different backgrounds but with a shared interest in food security, environments and livelihoods (see Box 2: Many stakeholders, diverse perspectives). The main steps were to set a suitable time horizon and then to identify the key drivers of change. The participants set the time horizon at 2030, since they felt this would allow sufficient time for planning at the regional level while still developing fairly detailed narratives.

Participants then identified the key drivers of future change, selecting those relevant to food security, environments and livelihoods, and listing them according to their importance and to the level of uncertainty associated with them. Two drivers were considered both highly relevant and relatively certain over the 2010–2030 period:

- *Population*: the levels of human population growth assumed in the scenarios are those projected by the United Nations Population Division for the region's various countries (United Nations Population Division 2010). These levels reflect 'intrinsic' population growth based on fertility, but do not include change due to immigration or emigration.
- *Climate change*: since climate models do not diverge strongly until after 2030, a 1°C global average temperature rise by 2030 and increased climate variability were used as a certain driver across the 4 scenarios (IPCC 2007). Future rainfall, though highly uncertain for Eastern Africa, was not chosen as a key uncertainty because the scenarios focus on socio-economic change and regional adaptive capacity rather than being climate scenarios. Instead, increased periods of drought were assumed as part of the single climate scenario (IPCC 2007).

Box 2: Many stakeholders, diverse perspectives

Involved in the scenarios' development and use process were 120 stakeholders from Kenya, Tanzania, Ethiopia, Uganda, Rwanda and Burundi as well as regional and global actors, including:

- Policy advisors from agriculture, environment, meteorology, and planning departments.
- Farmers' organizations under the East African Farmers' Federation.
- Private sector organizations such as the Ethiopian Horticulture Producer Exporters Association (EHPEA) and the Entrepreneurship and Leadership Foundation (E + L).
- Regional governance bodies: the East African Community (EAC) and the Lake Victoria Basin Committee.
- Regional research initiatives such as the Association for Strengthening Agricultural Research in Eastern and Central Africa (ASARECA).
- Regionally active Non-Governmental Organizations (NGOs) such as the Cooperative for Assistance and Relief Everywhere (CARE), the Oxford Committee for Famine Relief (OXFAM) and Caritas Internationalis.
- Researchers from the CGIAR Climate Change, Agriculture and Food Security programme and the University of Oxford.
- Regional media, represented by the Panos development journalism network.
- Intermediary CSOs such as the Society for International Development.



Figure 4. Participants in Dar es Salaam developing scenario narratives.

Two drivers were considered highly relevant for future food security, environments and livelihoods in Eastern Africa, but with high levels of uncertainty attached to them:

- *Regional integration*: Will the countries of Eastern Africa integrate politically and economically, or will a fragmented status quo be maintained?
- *Mode of governance*: Will governance – the rules, regulations, institutions and processes affecting the behaviour of individuals and groups – be characterized by a reactive or proactive stance of governments, the private sector and civil society?

These 2 ‘uncertain’ drivers were used to structure 4 scenarios (see Figure 5: Summary of the challenges and opportunities in the 4 scenarios in terms of food security, environments and livelihoods for Eastern Africa). However, the workshop participants identified many additional drivers and used these to inform different aspects of the scenario narratives. A few major events, principally a severe drought occurring in 2020–2022, were assumed to occur in each scenario to allow for comparisons to be made between them.

The Eastern African narratives developed by regional participants (Figure 5: Summary of the challenges and opportunities in the 4 scenarios in terms of food security, environments and livelihoods for Eastern Africa, and Figure 6: Cartoon representation of the scenarios, by artist Mauvine Were) and presented in this working report describe the effects of socio-economic and governance changes, their interactions with the early effects of climate change, and the consequences for food security, environments and livelihoods. They portray different worlds, each bound by its own combination of assumptions. The ways in which the assumptions play out are guided by the ideas of the story-writing groups at the workshops and represent only a selection of the many possibilities. The scenarios provide challenges and opportunities for those interested in exploring new strategies. Elements in some scenarios that could be considered positive might have negative consequences in the longer term future. Similarly, problematic situations may open up unforeseen opportunities. The names of the 4 scenarios originated with the workshop participants.

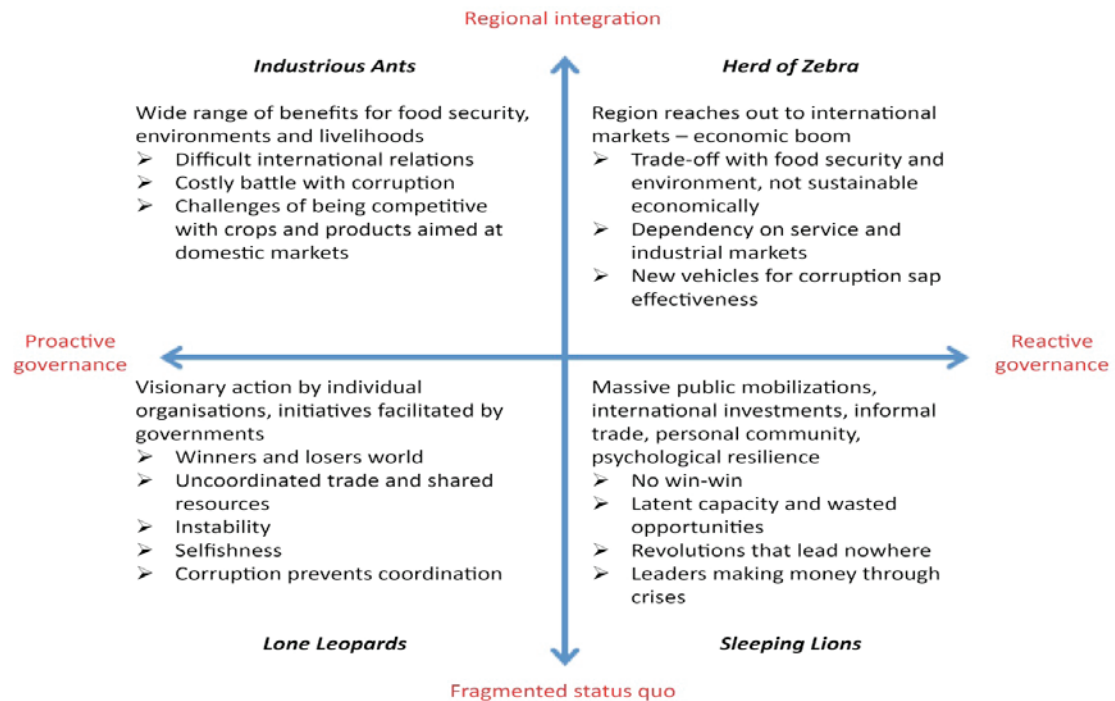


Figure 5. Summary of the challenges and opportunities in the 4 scenarios in terms of food security, environments and livelihoods for Eastern Africa.

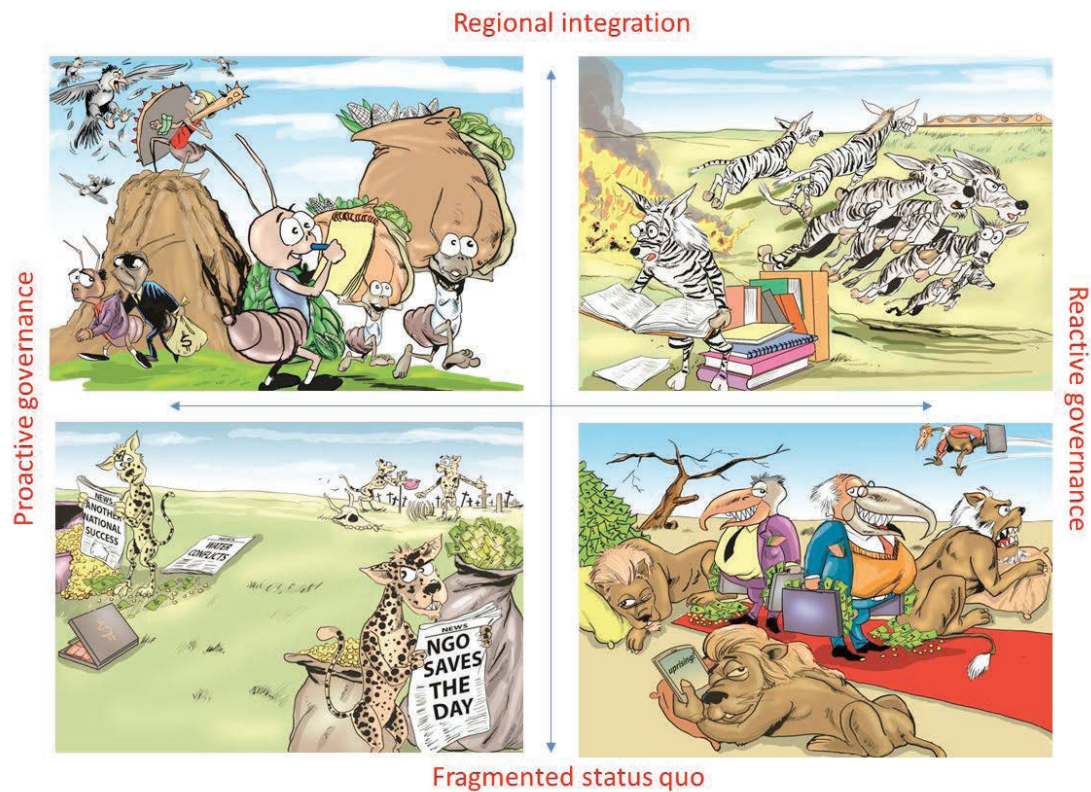


Figure 6. Cartoon representation of the scenarios, by artist Mauvine Were

Quantifying the scenarios

Modelling tools have been used to add rigour to the qualitative storylines, since they provide the quantitative data needed to ensure the suggested outcomes and indicators are credible. The teams used IFPRI's IMPACT model (Rosegrant et al. 1995) and IIASA's GLOBIOM model (Havlik et al. 2011). These are both 'partial equilibrium' models, meaning, in this case, that they simulate global market dynamics for agricultural products only, not for entire economies. Both models have strengths and weaknesses. IMPACT is designed to examine alternative futures for global food supply, demand, trade and prices, while GLOBIOM is designed to provide policy advice on global issues concerning competition for land among major production sectors. While IMPACT and GLOBIOM are global models, as part of the CCAFS exercise they are being modified to allow simulation for specific regions. Both models will be described in more detail later in the 'Model descriptions' section.

Quantification has several benefits. Illustrating the narratives with numbers gives prospective users more definite information that can be applied in the testing of policies and research recommendations. In addition, the models represent a structured set of assumptions that can be used to challenge the ideas proposed by the narratives and to make each narrative more internally consistent. However, using existing quantitative models also has drawbacks in the fact that the models have been designed based on the present rather than qualitatively different futures, and therefore there are limits with regard to the degree to which models can capture these futures. Also, quantitative scenarios of the future can easily and wrongfully be interpreted as forecasts with predictive value. Therefore, the presentation of quantitative results from the CCAFS scenarios process for Eastern Africa involves highlighting the limitations and assumptions of the models and showing that depending on the model as well as the scenario, very different futures come up. In an iterative process, the regional stakeholders challenged the modelling results if they thought these were not plausible from a regional perspective. Furthermore, the scenarios created by the regional stakeholders ask questions about the future that might challenge the model designers to adapt their models, creating a two-way interaction between the narratives and the modelling results for further improvement of the scenarios.

Using the CCAFS East Africa scenarios for research and planning

The CCAFS East Africa scenarios have been and will continue to be used in different contexts and at different levels to aid planning and research:

- *Strategic planning with non-government decision makers in the region:* a workshop in June 2012 invited representatives from civil society and the private sector throughout East Africa (Figure 7: Participants at the strategic planning workshop with non-state actors in Nairobi, coming up with their vision for East Africa in 2030, and Figure 8: Participants at the strategic planning workshop with non-state actors in Nairobi, covering the scenario diagram in their own notes.) to explore the feasibility of future partnerships and strategies for improving food security, environments and livelihoods. This workshop was challenging but successful, allowing participants to devise and test various strategies based on the perspectives of their organizations (see section: *Using regional scenarios in local futures and vice versa*).



Figure 7. Participants at the strategic planning workshop with non-state actors in Nairobi, coming up with their vision for East Africa in 2030.



Figure 8. Participants at the strategic planning workshop with non-state actors in Nairobi, covering the scenario diagram in their own notes.

- *Regional-level strategic planning with government decision makers:* the scenarios have been used in a workshop organized with the EAC in September 2012 to explore the feasibility of policies for improved food security, environments and livelihoods. This workshop led to a number of proposed policy actions and collaborations that are currently being developed (see section: *Using regional scenarios in local futures and vice versa*).
- *Research planning and prioritization:* a number of CCAFS research projects will use the scenarios to develop research recommendations for specific issues, including vector-borne diseases under climate change, migration futures, futures of pastoralists in East Africa, future grassland expansion, and climate mitigation in agriculture.
- *Exploring adaptive strategies with local communities:* CCAFS and its partners have organized a number of ongoing strategic planning processes with rural communities across Eastern Africa. As part of these processes, the scenarios will be used to inform local-level decision making.
- *Media dissemination:* CCAFS is collaborating with the Panos journalism network (<http://www.panosea.org/>) to produce a wide range of media reports (e.g. television news items, radio programmes, newspaper articles) that will raise awareness of the scenarios among a broad audience, including potential user groups. The outcomes of the various processes that use the scenarios will be disseminated in a similar way.
- *Support for global research:* the CCAFS scenarios for East Africa constitute a regional case study that can feed into global scenarios efforts, such as the Global Futures Hub organized by the Global Forum on Agricultural Research (GFAR, <http://www.egfar.org/>) and the Intergovernmental Panel on Climate Change (IPCC) Shared Socio-economic Pathways (Moss et al. 2010). Members of the CCAFS scenarios team and their partners have already established links with these global processes.

Scenario narratives

Sleeping Lions – a story of regional fragmentation and reactive governance

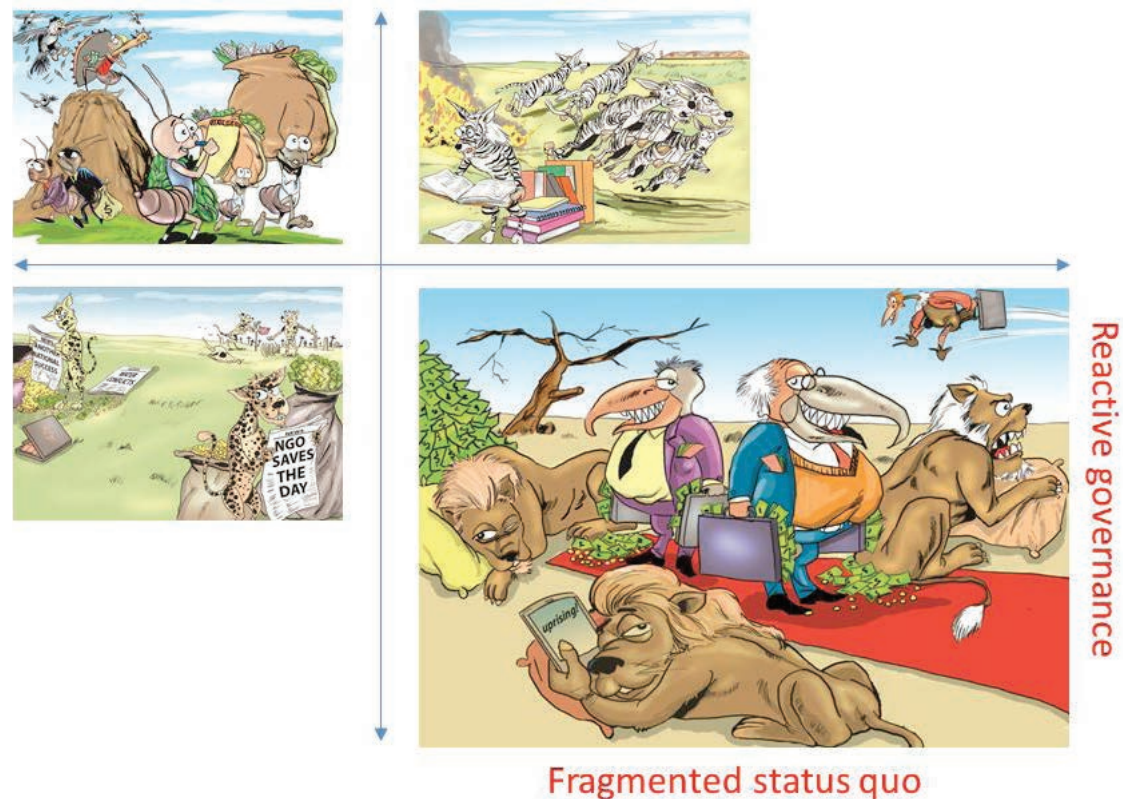


Figure 9. Sleeping Lions.

Summary

This scenario is all about wasted potential and win–lose games. Governments in 2030 act only in response to serious situations and in ways to further their own self-interests, thereby allowing foreign interests free rein in the region. Their actions – or lack of them – have devastating consequences for East Africans’ food security, livelihoods and environments. Conflicts, protests and uprisings are common, but each time reform is promised, it fails to materialize. The lack of coordinated effort on climate change and its impacts means that a severe drought occurring in 2020–2022 results in widespread hunger and many deaths among the region’s poor and vulnerable. It is only the adaptive capacity and resilience of communities, born out of decades of enforced self-reliance based on informal economies, collaboration and knowledge sharing that mitigates the worst effects of this disaster. The first signs of better governance emerge only in the late 2020s, but the region’s population still faces a very uncertain future.

Governance: see nothing, hear nothing, do nothing

Between 2010 and 2030, East African countries experienced numerous political regime changes. While plans for common trade and market platforms and visions for the opening of country borders for trade and employment were developed, no tangible instruments were put in place to establish a regional governance system within which countries could operate as a regional bloc. Instead, each country concentrated on the factors that benefit only its

limited national interests at the expense of others. Governments developed relationships of convenience with international investors, bringing virtually no benefits at all to the political, social and economic development of the region.

By 2025, the Democratic Republic of Congo, Kenya, Tanzania and Uganda had officially acceded to most of the clauses governing regional economic cooperation, but South Sudan and Ethiopia continued to be sceptical of full integration. As of 2030, there is still no agreement on a common market, currency or political leader. Integration is hampered by conflict, famine, lack of resources for development projects, and lack of capacity to formulate and harmonize regional policies. Operationally, the Common Market for Eastern and Southern Africa (COMESA) and the Intergovernmental Authority on Development (IGAD) are the only regional frameworks, but these have had little impact on economic development. One major achievement is the introduction of a regional conflict early warning centre and peacekeeping initiative in 2024.

At the same time, levels of corruption have increased, forcing governments to spend large amounts of public money on self-defence (e.g. commissions of enquiry and national anti-corruption organizations) rather than investing in economic development. However, every newly elected government has been anxious to develop regulatory frameworks to combat corruption, and several countries have embarked on a process of constitutional reform. Corruption has been accompanied by autocratic tendencies, with ruling elites clinging to power – even when this affects the country’s stability – and refusing to introduce measures to improve democracy and governance and guarantee human rights. Free and fair elections have remained an elusive goal, and elections continue to be associated with violence.

By 2030, when repeated public protests and other outbreaks of unrest have failed to lead to tangible change, the citizens of leading countries (e.g. Ethiopia and Kenya) have developed strong political awareness. Emerging pluralism and participatory democracy have finally led to the first modest signs of improved governance in these countries, sparking hope for the rest of the region. Political parties are now more powerful, with politics dominated less by idiosyncratic strong-men, and persistent lobbying by activists has enlarged the democratic space. However, old habits still curtail administrative openness, institutional accountability and hence economic development. A few good national policies, often driven by donor agendas, have attempted to address poverty, agricultural development and environmental protection, but political incompetence and vested interests have prevented their full implementation.

Power struggles at the regional level and unilateralist approaches within countries have undermined the region’s economic growth. Despite intervention by the African Union, United Nations, United States and European Union, the impasse has not been overcome. Meanwhile, civil war continues in the Democratic Republic of Congo, Somalia and Sudan, with regional piracy, terrorism and kidnapping (e.g. by Al-Shabaab) increasing in the countries bordering the Indian Ocean. Such instability has all but prevented the free movement of people, goods and services and, at the same time, led to an influx of refugees to the more stable countries and an overall increase in the number of displaced people.

The harmonization of policies was complicated further by inter- and intra-regional conflicts, the spread of HIV/AIDS and attentions focused on the adoption of new development programmes at the continental level, for example the New Partnership for African Development (NEPAD) although some benefits from the latter had begun to trickle down to relatively poor people in a few areas. Lack of positive government action led to a rise in the numbers and activities of regional CSOs. Similarly, NGOs – especially international and

regional ones – grew in power and resources towards 2030. However, these organizations failed to stimulate large-scale change in food security, environments and livelihoods because of a lack of cooperation on the part of the governments. The smaller NGOs, in particular, were often confrontational in their stance towards government and the private sector, adding to the divisive nature of the political discourse.

There are a few instances where the dictates of the global economy and global agreements on climate change have been reflected in regional agreements, but this has been done with little or no consideration for the compatibility of such initiatives with the existing regional policy environment. Individual countries have aimed to win concessions and access funding at the expense of others. While some countries have attracted strong foreign investment (particularly from Asia), agreements have been made in such a way that they have benefited only the elites in society and foreign companies, and have undermined local enterprise (e.g. in agricultural and infrastructural development). Furthermore, foreign investors have not been obliged to comply with environmental regulations, and their development projects have been associated with pollution, increased greenhouse gas emissions and displacement of people, leading to conflict over land and other scarce resources. In some countries (e.g. Ethiopia), foreign multi-nationals have been allowed to convert large areas of forest for the production of biofuel and food crops. With financial profits taking precedence over all other considerations – including environmental resource management – land degradation and overexploitation have negatively affected ecosystem health. However, local people have gained some opportunities to learn skills and apply modern technologies to improve agricultural production efficiency, but mainly as workers on commercial farms rather than as traditional smallholders. In the meantime, the land-grabs of earlier decades have grown through deals made between governments and international investors.

Rising food prices have presented opportunities for East African countries to promote agricultural and rural development, but this opportunity has been hampered by inadequate infrastructure, weak institutions and lack of political will to implement supportive policies.



Figure 10. Sleeping Lions: “While some countries have attracted strong foreign investment ... agreements have been made in such a way that they have benefited only the elites in society and foreign companies, and have undermined local enterprise.”

In the international arena, a financial crisis in 2015 (similar to the 2008 ‘credit crunch’) only worsened this volatile situation, leaving many countries in debt to Asian governments and investors, particularly those from China.

In 2030, the regional economy is highly dependent on cross-border trade. Formal cross-border trade supposedly improved in 2010, with the signing of the East Africa Market Protocol. However, economic relationships between countries have since become more problematic, with poor governance and corruption at border posts leading to an increase in informal cross-border trade and even to localized conflicts between neighbouring countries.

Infrastructure: foreign roads for foreign cars

Driven mainly by foreign investment, transport and communication infrastructure has improved significantly in urban and industrial areas, but there has been little change in the more remote rural districts. Corruption has led to the misallocation of funds, with money channelled to uneconomic high-profile projects rather than to the provision of roads, hospitals and schools for the broader population. There has been a slight increase in electrical grid capacity, but only a quarter of the population has access to electricity.

The lack of infrastructure, particularly in rural areas, is stalling economic growth and widening the gap between rich and poor. In rural areas, farmers and other entrepreneurs are unable to compete due to lack of access to markets and high input and production costs.

Livelihoods: communities on their own

Although livelihood opportunities have improved in parts of East Africa, particularly in Kenya and Ethiopia and in urban centres, most people have fewer options in 2030 than they did 20 years earlier. Furthermore, average incomes for the poor are lower than they were in



Figure 11. Sleeping Lions: “Corruption has led to the misallocation of funds, with money channelled to uneconomic high-profile projects rather than to the provision of roads, hospitals and schools for the broader population.”

2010. Lack of free movement across borders prevents migration for work, while persisting conflict forces people to flee their homelands. At the same time, drought, poor environmental management and the rise of large-scale commercial agriculture continue to drive rural people out of the agricultural sector. Poor smallholders still lack access to credit and so are unable to invest in improvements to their farm-based livelihoods.

Migration from rural to urban areas has broken community ties, but in the absence of proactive governance, civil society and community-based self-help groups have increased greatly in number, in both rural and urban areas. Better communication technology, particularly the spread of mobile phone use, has helped these groups to function and disseminate knowledge, which is particularly useful for smallholders and pastoralists in remote rural locations. Foreign investment by the private sector has partially met the demand for agricultural scientists by making funds available for capacity building, but this has been aimed principally at commercial agriculture. Government funding for public sector agricultural research remains very low, despite some support from donor agencies.

Health care remains the privilege of the middle classes and the wealthy elite, with the poor largely unable to access health care services. Donor funds for health care have been cut in response to a long history of corruption in the allocation of funds.

Agriculture: lambs to the slaughter

In 2010, 90 percent of East African farmers were smallholders, with only 10 percent engaged in commercial agriculture. By 2030, due to investment and land grabbing by the multinationals and by foreign governments, many smallholders have given up and migrated to the cities, while a minority have found jobs as farm labourers in commercial agriculture, often under exploitative conditions.

Rising oil prices have prompted governments and investors to convert large areas of agricultural land to biofuel production at the expense of food crops, putting their countries at risk of rising food prices and food insecurity for the vulnerable and poor, due to the need to import food.

A rise in the number of wealthy urbanites has created a demand for processed food. On the positive side, this trend has attracted foreign investment and created new jobs in the agroprocessing industry. But the down side is that the nutritional value of urban diets has fallen, with no government attempts to set matters right.

There is no single East African voice on market access, domestic support, export subsidies and other pertinent issues for the agricultural sector. The lack of a regional trade policy leaves East African markets open to cheap imports of food and other products from China and elsewhere. To compete, local industries and smallholders are forced to accept very small margins. The absence of functioning market institutions further hinders producers, since they are unable to take advantage of global market opportunities; the middlemen are always in the way and have free rein to exploit producers. However, the relentless increase in mobile phone technology does offset this dependency to some degree, providing farmers with direct market information.

By 2030, governments are increasingly failing to allocate 10 percent of gross domestic product (GDP) to agriculture, as agreed in the 2003 Maputo Declaration. This is reflected in the lack of rural transport and power infrastructure, the subsequent lack of active rural markets, and the underfunding of national agricultural research and extension systems.

Increasing rainfall variability and drought have severely constrained agricultural production, with farmers relying more and more on simple water harvesting solutions. Few advanced technologies are available to them. The effects of increased rainfall variability are reflected

in falling average yields across the smallholder sector, while large-scale commercial crop production, which relies largely on irrigation, is affected less.

Between 2020 and 2022, a severe drought affected much of the region. Governments had little capacity to respond and, as a result, famine conditions leading to deaths from starvation and disease were high. The lack of infrastructure and government support hampered humanitarian relief efforts, particularly in remote rural areas.

Extensive livestock producers (pastoralists) were already experiencing problems due to climate change and desertification in 2010 and by 2030 they have suffered greatly from a combination of drought, marginalization and other factors. Pressure on pasture lands leads to overgrazing, land degradation, soil erosion and conflicts over resources, particularly water. The result is a downward spiral of falling livestock numbers and rising poverty in pastoral and agropastoral communities. In times of drought, pastoralists must move their animals to new areas, often across country borders. This not only increases environmental degradation and conflict over land and water but also spreads animal diseases.

Food security: empty hands

Since the region has been heavily dependent on food imports, rising global prices are triggering macroeconomic instability – including high inflation – and levels of poverty and hunger are increasing among both rural and urban populations.

Government policy has long focused agricultural production on exports. There has been insufficient investment in the production of food staples, thereby putting the region at risk of food insecurity when food import prices experience a spike, as they often have done during years of harvest failure elsewhere in the world. This policy also discourages smallholders from producing food for the domestic market when import prices are low. Price volatility undermines the confidence needed if entrepreneurial small-scale farmers are to invest in technological improvements or new enterprises for food staples.

The lack of investment in domestic agriculture also means that countries are insufficiently prepared for the consequences of climate change. There is limited technology and knowledge available for formulating and implementing mitigation and adaptation strategies. The lack of data means that most farmers continue to rely on local knowledge. Some support for the development of climate risk adaptation and mitigation policy has been available from international organizations, but policies have yet to be implemented due to a lack of capacity and accountability.

The devastating drought of 2020–2022 caused several years of poor harvests and the past 20 years have been characterized by a continuous risk of famine. However, government responses over the past decade have not reflected this urgency, with too much talk and too little action – no substantive policy development and no programmatic efforts to address the challenge, neither at the national nor regional level.

Individual countries continue to rely on food aid and development projects, which are implemented in piecemeal fashion with little consideration for sustainability. In response to widespread food insecurity, and in the absence of government action, NGOs have been investing in agricultural research and development, but not always very competently.

Environments: fallow lands

In 2030, many East Africans are still living in poverty. In addition to prompting migration, particularly away from marginal lands and towards cities, this is placing great stress on natural resources. Measures on the environment have been largely reactionary and prompted by environmental crises (e.g. the Great Drought).



Figure 12. Sleeping Lions: “Between 2020 and 2022, a severe drought affected much of the region. Governments had little capacity to respond and, as a result, deaths from starvation and disease were high.”

In the absence of regional agreements on the sustainable management of trans-boundary natural resources (e.g. Lake Victoria and the Nile River basin), a ‘do-it-yourself’ approach has emerged. This has caused tension among the countries that share water resources and rangelands, with fishermen and pastoralists being prevented from continuing their traditional migrations across national boundaries, and undermining cross-country institutions and collaboration.

By 2030, changes in rainfall and temperature have led to an increase in tropical woody vegetation at the expense of grasslands. This in turn has led to an increase in total carbon storage over 2010. However, deforestation continues apace, with traditional reserves of mature forest particularly badly affected.

Deforestation has been driven by the expansion of commercial agriculture, coupled with government failure to introduce and apply regional sustainability or environmental protection. These factors have also led to increased soil erosion and rising sediment loads in rivers and lakes. Other types of land conversion, such as quarrying and mining, have also contributed to soil erosion and carbon depletion. At the same time, the use of agricultural chemicals has risen, causing pollution and eutrophication in water bodies. By 2030, although new technologies implemented by governments have reduced the use of some polluting chemicals, eutrophication continues to increase.

Demand for forest resources and expansion of agriculture have affected regional biodiversity, with the loss of several keystone species. Civil society movements have put pressure on governments to apply the United Nations Collaborative Programme on Reducing Emissions from Deforestation and Forest Degradation (REDD) in Developing Countries and increase forest cover. However, there is little collaboration between international and local conservation organizations.



Figure 13. Sleeping Lions: “Deforestation has been driven by the expansion of commercial agriculture, coupled with government failure to introduce and apply regional sustainability or environmental protection.”

Lone Leopards – a story of continued fragmentation but proactive governance

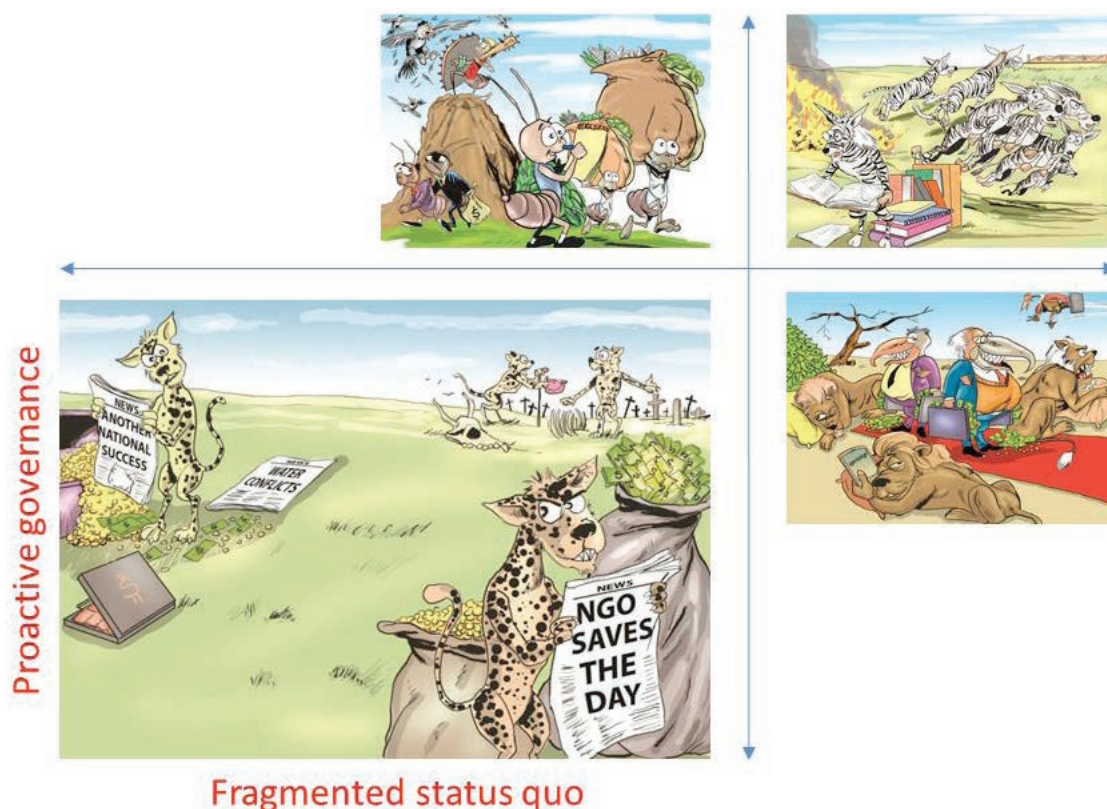


Figure 14. Lone Leopards.

Summary

In this scenario, regional integration exists only on paper by 2030. In reality, government and non-government institutions and individuals are busy securing their own interests. In terms of food security, environments and livelihoods, the region initially seems to be heading for catastrophe in the 2010s. However, after some years, national and international as well as government and non-government partnerships become more active and, unburdened by strict regional regulations and supported by international relations, are able to achieve some good successes by the 2020s. Unfortunately, because of the lack of coordination, this is a hit and miss affair, with some key issues ignored while on others there are overlapping or competing initiatives. The inability of governments to overcome regional disputes and work with one another becomes untenable when a severe drought hits in 2020. This pushes civil society, bolstered by international support, into a demand for radical change in governance. In many cases, the resulting change is long lasting and for the better.

Governance: divided we succeeded?

Politically and economically, Eastern Africa is in a difficult position in 2030. Countries seek to maintain the status quo (i.e. national sovereignty) in such key areas of policy as food security, natural resource management and livelihoods development, while forging bilateral links with powerful trading partners such as India and China. National self-interest trumps regional cooperation almost every time, particularly in relation to economic, political and military agendas.

The five countries of the EAC – Burundi, Kenya, Rwanda, Tanzania and Uganda – have not experienced significant economic benefits or foreign investment as a result of their attempts

to increase cooperation. Nor have countries outside the EAC such as Ethiopia come under pressure to join or at least strengthen their ties. Although the limited regional cooperation established in 2010–2015 has created somewhat better access to shared markets and natural resources, economic development has not followed to the extent anticipated. This is due to the inflexibility of individual countries and the fact that they have made bilateral and exclusive agreements with the Asian superpowers and other foreign investors, rather than more equitable regional arrangements.

Political divisions have undermined the collective implementation of effective regional policies and weakened the negotiating power of the region on the global stage. Power struggles among member governments for control of the EAC have further impeded progress. Potential new member countries, such as Somalia and South Sudan, have never been seen as sufficiently stable to join. The competitive interests of individual states have prevailed at the expense of collective strength, allowing external agents to manipulate governments and play countries off against each other with regard to critical investments and policy decisions. International interests from the North and East have also exploited the corrupt elements in governments. However, both government and non-government institutions and individuals in specific countries have had a good deal of freedom to pursue their own agendas on development and environment as they have seen fit, not having to go through a regional platform first.

In 2020, the EAC started to implement a regional network for economic and market cooperation, removing tariffs on trade between member countries. However, this has failed to be implemented fully by member states, which have continued to act in their own short-term interests. The supply of food products with poor nutritional value into the region has continued unchecked, because regional-level policies to regulate food quality are absent.



Figure 15. Lone Leopards: “National self-interest trumps regional cooperation almost every time ... The competitive interests of individual states have prevailed at the expense of collective strength.”

The less competitive countries (e.g. Ethiopia and Burundi) are experiencing foreign currency depletion as investors move their funds into more successful countries (e.g. Kenya and Uganda) where there is more belief in the economy.

The lack of regional governance initiatives has allowed tensions to build and political instability to flourish, with serious conflicts over natural resources either erupting or simmering. Among the countries with more successful economies, this tension has expressed itself mainly politically and economically, for example through trade disputes, but weaker areas or countries have acted as a crucible for violence, which has spilled over to neighbouring countries from South Sudan and Somalia. The violent organizations that operate from within these war-torn countries have been exploited by different sectarian or religious factions to further their own goals, a bitter reality that has featured in a number of atrocities. The resulting instability has increased the number of internationally displaced people and refugees.

Ultimately, failures at the regional level have led to civil unrest. But, because coalitions of local and international NGOs and CSOs have developed so strongly in the absence of regional structures, there have been articulate and persuasive calls for change in national policies. These have recently been reasonably successful, especially in Ethiopia, Kenya and Uganda, where the potential for positive change was already highest.

Even before these changes came about, partnerships between governments and international and local NGOs and CSOs had been active in a variety of fields, including food aid, soil conservation, afforestation and community health. Their increasing influence has been reflected in broad media coverage. However, in 2030 there is still inefficient regional coordination of resources and skills and most local and national NGOs and CSOs continue to rely on financial support and capacity building from international organizations.

Infrastructure: tarmac here, dirt roads there

Infrastructure development has been very inconsistent throughout the period to 2030. Different national policies with regard to foreign investors and aid grants have had different degrees of success. Regional road and rail networks in Kenya, Tanzania and Uganda have been improved massively, the power grid has been overhauled, and ports and harbours have been upgraded. However, other countries have lacked the finance and expertise needed to develop infrastructure on beneficial terms.

Livelihoods: it's not who you are, it's who you know

The Eastern African economies are highly diverse in 2030. The larger economies (Kenya, Tanzania and Uganda) have done best in terms of development but, due to economic discord, there has been relatively little positive spillover into other economies. Initially, there was little progress with regard to poverty reduction and social advancement. There was a lack of access to affordable credit, producers received low prices and inflation rates were relatively high, all of which led to food insecurity and malnourishment, preventing the poor from creating enterprises to lift them out of poverty. Large numbers were forced to rely on food aid. Meanwhile, the wealthy had sufficient good quality food and could afford to pay for electricity and clean water. Education and welfare have stagnated, except where it is in the interests of the private sector to deliver services to their employees and customers. Gaps between rich and poor and between rural and urban dwellers have widened significantly. By 2030, thanks to long-running support programmes implemented with government support by NGOs and CSOs, the income gap has closed in some countries (e.g. Kenya, Rwanda and Uganda). In others, the success of such initiatives has been less clear-cut. Overall, there are

many local success stories, but millions of urban and rural poor remain excluded from the benefits of economic growth.

Initially, weak government support for health-care facilities meant that the middle classes were more or less unable to afford health care. CSOs later pushed such governments as Kenya and Uganda into action, and Ethiopia and Burundi have developed alternative support structures to raise funds for health insurance.

Coalitions of governments, local and international NGOs and CSOs have made a concerted effort to harness information and communication technology and the dissemination of knowledge in rural areas. Kenya leads the way in this and there has been some exchange of lessons from this country among international NGOs, despite national distrust and competitiveness. Ethiopia has been less successful, due to the government's struggles to get the appropriate next-generation infrastructure funded and installed.

Governments compete to reach agreements with foreign investors that will benefit national development and job creation, with many examples of success as well as a few disasters scattered across different countries and sectors. The less successful efforts have often been associated with corrupt politicians. Meanwhile, workers try to migrate to the more successful economies, but borders are generally tight. Illegal migration has become a growing problem where borders are less well policed.

Agriculture: power dynamics in the value chain

East Africans continue to depend on agriculture to drive economic growth and provide livelihoods, but the proportion of people employed in the sector has fallen. The growth of private-sector cash cropping for export markets has created relatively few jobs because most enterprises are highly mechanized. Meanwhile, many smallholders and pastoralists have gone out of business and moved to the cities. Agricultural enterprises are sharply divided into commercial, hi-tech cash cropping and the production of animal feed for export, both of which are profitable for the relatively few farmers involved, and low-input crop and livestock production on marginal land, which are scarcely viable and practised by the many, mainly for local consumption. Collaborative research on drought-tolerant maize was strengthened by using a networking approach, but was slow to get off the ground because national governments refused to support the network.

Expansion of the commercial farming sector led to the widespread adoption of new technologies and greater application of inputs, including fertilizers and irrigation, but few benefits for smallholders. Contract farming for cash export crops (e.g. flowers, sugarcane, pineapple and citrus) grew dramatically, but this benefited only a few large-scale farmers.

Before the drought, food crops such as maize were generally sold soon after harvest, when prices were low but farmers were desperate for cash. They were bought mainly by businessmen, who held the grain in store and sold it back to farmers at a higher price during the dry season. Traders also sold staples across borders, earning themselves handsome profit margins that were not shared with farmers. Regional and global market access fell increasingly into the hands of a few large players at the expense of smallholders. The middleman reigned supreme.

However, by the mid-2020s, after the devastating drought, broad coalitions of government and NGOs emerged and began providing increased support for the diminishing number of smallholders. In addition to offering direct support for agricultural development, these coalitions tackled inequalities in value chains, sometimes successfully and sometimes not. Improved communication technology, especially mobile phones, was a key factor in the

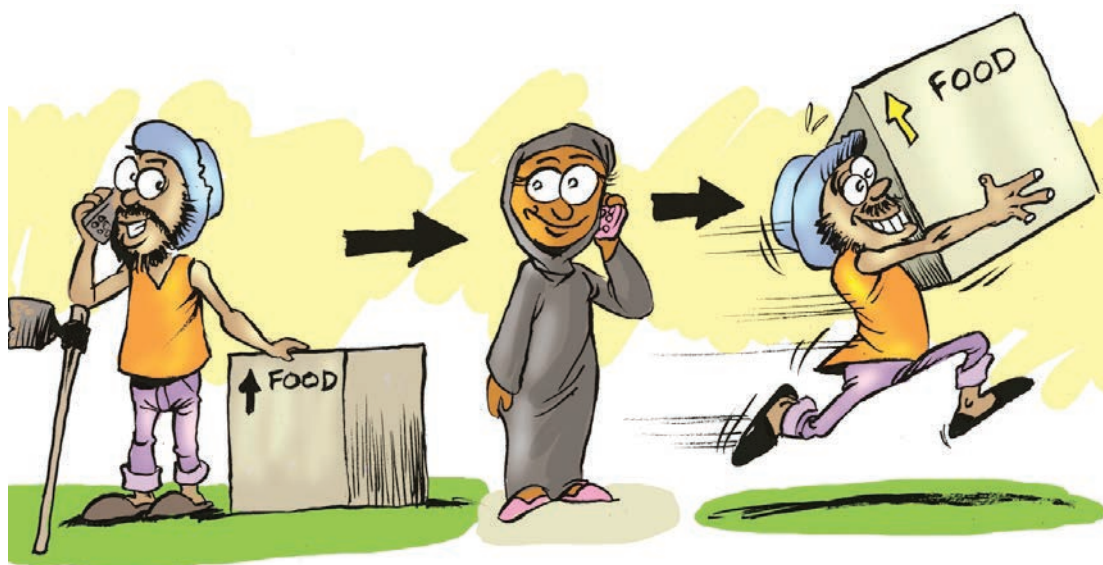


Figure 16. Lone Leopards: “Improved communication technology, especially mobile phones, was a key factor in the successful outcomes, especially in the more remote areas where they proved indispensable in linking farmers with buyers and with new forms of support, such as banking services.”

successful outcomes, especially in the more remote areas where they proved indispensable in linking farmers with buyers and with new forms of support, such as banking services.

The dominance of foreign powers in the region’s agricultural systems influenced the initial focus of knowledge development on high-input agriculture, which was funded by foreign investors in collaboration with national governments. Civil society attempted to shift this balance and, by the mid-2020s, successful large-scale knowledge development projects had taken off, with good examples in Tanzania and Uganda. By 2030, active collaboration between NGOs and donors, not supported but also not restricted by regional policies, helped secure an increase in funding for small- and medium-scale agricultural producers.

Food security: a double whammy

The year 2010 marked the establishment of the EAC Food Security Action Plan. It was envisaged that the Plan would guide the coordinated planning and implementation of joint programmes and projects geared to achieving and sustaining food security. However, despite increasingly successful efforts by a number of coalitions, most EAC member countries failed to achieve food security by 2030 and the EAC Food Security Action Plan is dead in all but name.

From 2015 to 2020, commodity-based private sector companies in the region organized themselves to take advantage of market opportunities, but because of fragmentation and competition they could not gain sufficient market access across the region. As a result, intraregional trade remained limited and people became heavily dependent on imports from outside Eastern Africa, with prices depending greatly on fluctuating global markets. Grain traders in some countries took advantage of food shortages that were already emerging before the drought, to raise their prices, with devastating effects on the poor, who were ill-prepared for food shortages.

The region’s vulnerability to global markets became painfully clear when the severe drought hit in 2020, at a time of high food prices, causing hardship on a huge scale. However,

humanitarian aid was mobilized rapidly and effectively, since several countries and areas already had experience in proactively securing international donor funds and collaborating with international NGOs. This time, international organizations were asked to go beyond the initial disaster mitigation phase to help build a better food security strategy.

In 2025, with the Great Drought still fresh in people's minds and with internationally influenced political reforms focusing more on regional integration, there was discussion on the need to establish an EAC Strategic Grain Reserve (the policy was there, but the funds were not). In 2030, this opportunity has yet to be realized. Instead, several larger countries have established their own food banks with the help of NGOs and CSOs, rather than waiting for bureaucrats and politicians to create a regional reserve.

By 2025, governments and the private sector in the bigger economies were collaborating to promote trade with producers outside the region and value chains within countries that improved the availability of affordable food. However, the smaller economies had less power to influence the equity of trade relations internationally and were unable to provide price buffers nationally, resulting in greater fluctuations in food availability and higher prices overall.

Urbanization and rising middle-class incomes have led to an increase in the consumption of processed and junk food, the proliferation of which is often supported by the actions of governments in building international trade relations. The increased demand for processed food has stimulated growth in storage and processing facilities, both as large-scale facilities and through the purchase and use of fridges at household level.

Food security is linked directly to the availability and quality of natural resources – that is, water and soil. The initial lack of policies on sustainable natural resource management has had a detrimental effect on food security, but towards 2030 this begins to change, with new environmental coalitions stepping in.

Environments: one step back from the brink

By 2020, East Africa's natural resources were under extreme threat of collapse. The focus of individual countries on export agriculture and the lack of policies and legislation to protect the environment and biodiversity had led to widespread environmental degradation, species loss and diminishing soil fertility, amongst other indicators of environmental ill-health. Governments continued to ignore the need to harmonize national strategies and policies, for example on strengthening meteorological services, protecting water resources and establishing environmental monitoring networks. They had also failed to streamline strategies for adapting to climate change. There was considerable disagreement among countries regarding the most appropriate regional policies, while the adoption of national and sectoral policies effectively undermined regional development and weakened collective decision making.

In 2015, the EAC member states developed a comprehensive Climate Change Policy to address affected sectors such as water, agriculture, energy, transport, health, forestry, wildlife and infrastructure. The Policy was consistent with the provisions of the East African Treaty, the EAC Protocol on Environment and Natural Resources, the Protocol on Sustainable Development of the Lake Victoria Basin and the United Nations Framework Convention on Climate Change (UNFCCC). However, political infighting delayed implementation indefinitely.

At the local level, civil society groups have been working closely with communities to ensure investment in the water sector. These groups have built or strengthened the capacities of communities in conflict prevention and resolution by harnessing local institutions and

an existing culture of dialogue. Locally, this has led to the better use of water resources, but because many water issues in East Africa cross national frontiers, the lack of regional integration still prevents the attainment of water security or sustainable transboundary water resource management. Some of the poorer, less politically stable countries downstream, including several outside the region, have suffered from water access problems over the past 20 years, with the economically dominant upstream countries controlling resources and undermining commitments to equitable sharing and the efficient use of transboundary water resources.

Since 2020, foreign investors have boosted the region's water infrastructure and introduced water-saving technologies to areas of high agricultural potential, especially in Ethiopia and Kenya. A number of hydro power schemes, developed through investments by the Global Climate Change Adaptation and Mitigation Fund, have been introduced, powering economic development and enhancing some aspects of environmental sustainability, especially the reduction of carbon emissions. Unfortunately, however, these schemes have only added to regional disputes over access to water and displacements due to water shortage.

Climate change has worsened water scarcity and increased the potential for conflicts over water and land. This is exacerbated by political instability, governance problems, activities of liberation movements, post-election disturbances and civil wars. However, by 2030, strongly encouraged by foreign donors and international NGOs and with resources made available by the Global Climate Change Adaptation and Mitigation Fund, the EAC has started to introduce more effective regional transboundary water policies, recognizing both the urgency and the benefits of dealing with water security on a regional basis.

Fuelwood supplies have become scarcer due to deforestation, leading to a rapid increase in prices and accelerated forest degradation. Only since 2024 have local NGOs and CSOs begun working with national governments and global donor and development organizations to halt deforestation and other non-sustainable land conversion practices. Meanwhile, pastoralists have had to extend their traditional migrations due to rangeland degradation and the expansion of cropping. Their increasing need to travel across national borders has caused international tensions, but no effective solutions have been found. Many have become taxi drivers in the region's larger cities, while others have taken other low-skilled construction or quarrying jobs.

Overall, in the decade leading up to 2030, there have been a few success stories but, in general, regional and national capacity to respond to emerging environmental challenges remains weak. However, during 2030 itself, the first signs of real change in government policy towards regional integration appear. After years of unrest caused in part by environmental degradation, governments have begun working with NGOs to develop and introduce sustainable development plants for the most important regional resources, including the Nile Basin and Lake Victoria. In Kenya, the Green Belt movement, which began as a minority pursuit, is now widely supported throughout urban and rural areas across the nation. Copy-cat movements have started in a number of other countries.

Herd of Zebra – a story of strong regional integration but reactive governance

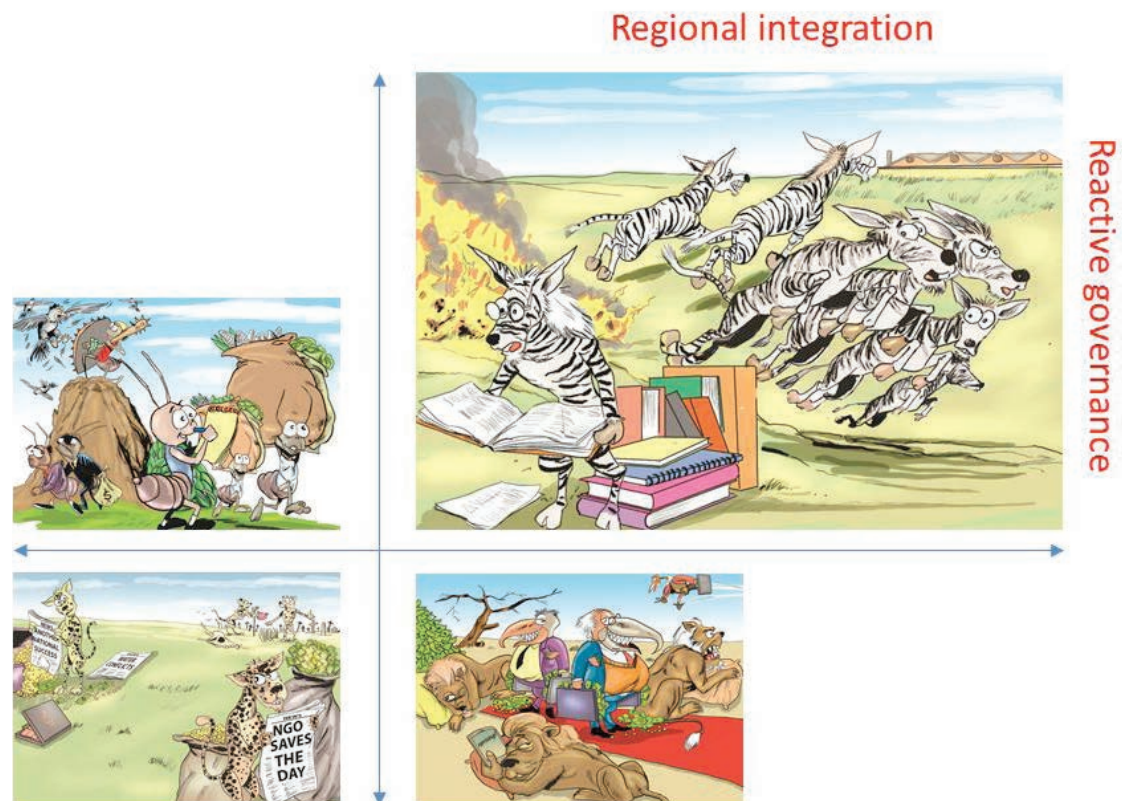


Figure 17. Herd of Zebra.

Summary

In this scenario, governments and the private sector push strongly for regional development, but mainly through industry, services, tourism and export agriculture, with limited action on food security, environments and livelihoods. East African economies boom, but the region suffers the consequences of its vulnerability to global market forces and unsustainable environmental exploitation. Only when food insecurity becomes extreme, following rocketing food prices during the Great Drought of the early 2020s, is action taken to improve the management of water resources and invest in climate-smart food production for regional consumption.

Governance: Eastern Africa as a business

The EAC in 2030 is a trade-oriented, open regional federation with eight member states (Burundi, Ethiopia, Kenya, Rwanda, Somalia, South Sudan, Tanzania and Uganda). A common market and currency, together with improved infrastructure and harmonized laws and policies, have led to steady economic growth. However, improved infrastructure and information technology have permitted increased exploitation of natural resources, with worsening environmental degradation.

In 2030, although the EAC is performing well with regard to economic development and trade, it has few policies in place on food security, climate change and environmental management. This is compromising the region's ability to participate in global sustainability initiatives and is beginning to affect exports. For example, there are few regulations to control pollution from manufacturing and agroprocessing industries, so the resulting products

do not meet new global standards for pollution-free products. Furthermore, international development partners are pulling out of the region because the EAC is failing to comply with environmental treaties and agreements. This is limiting the potential for market growth and the Community's economy now relies heavily on regional players, especially in the private investment and tourism sectors.

During and after the severe drought of the early 2020s, the region was no longer able to supply its export markets and GDP began to fall. In an attempt to restore growth to its previous levels, the regional government began to bend the rules and make exceptions for external investment, leading to a decline in both ethical and environmental standards. Despite strong regional integration, corruption is rife among decision makers and law enforcers. Those with power continue to monopolize resources and reap the rewards, with the poor becoming increasingly dependent on informal markets that lie outside the cash economy.

Infrastructure: paving the way for industry

Substantial investments in infrastructure have been made through public–private partnerships, leading to rapid industrialization. There is a thriving private sector, driven by domestic and foreign direct investment, particularly in the areas of mining, forestry, construction, manufacturing and tourism. Much of the region's agricultural production is exported to India and China. Improvements in transport and communication have attracted foreign investment in advanced agricultural technologies, including genetically modified varieties, agrochemicals and mechanization. Together with supporting regional government policy, better road and rail networks and other infrastructural improvements have attracted investment from foreign private sector companies, creating employment, new towns and industrial estates. The focus on agriculture as a driver of economic growth has diminished, except as a provider of luxury products and non-food commodities that provide opportunities for collecting taxes from new businesses.

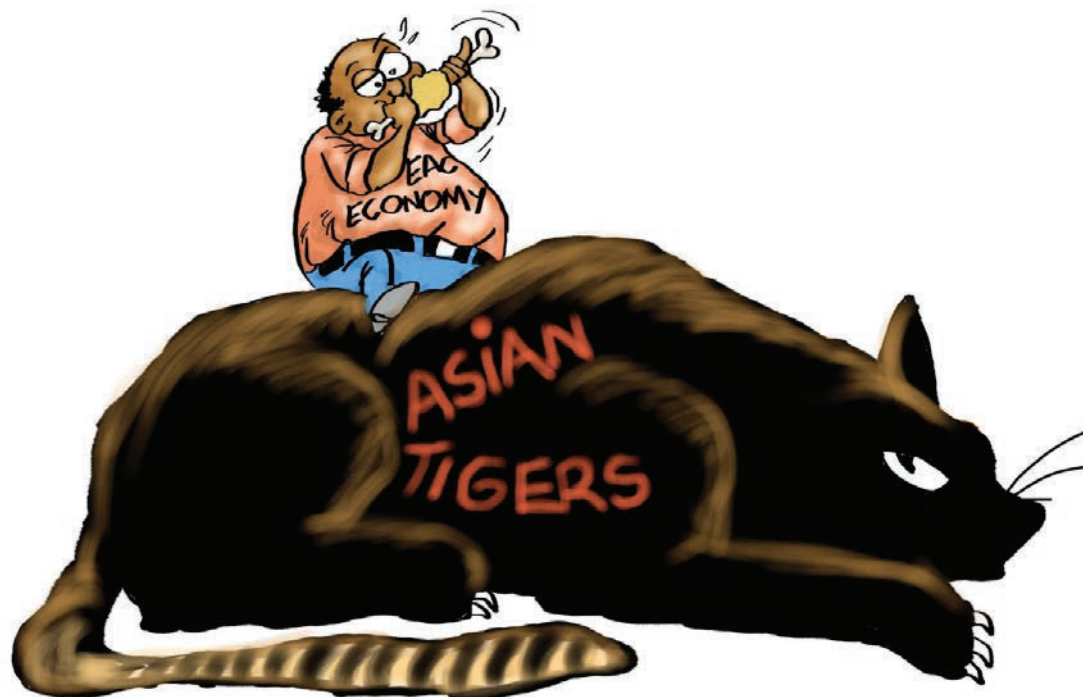


Figure 18. Herd of Zebra: “There is a thriving private sector, driven by domestic and foreign direct investment, particularly in the areas of mining, forestry, construction, manufacturing and tourism.”

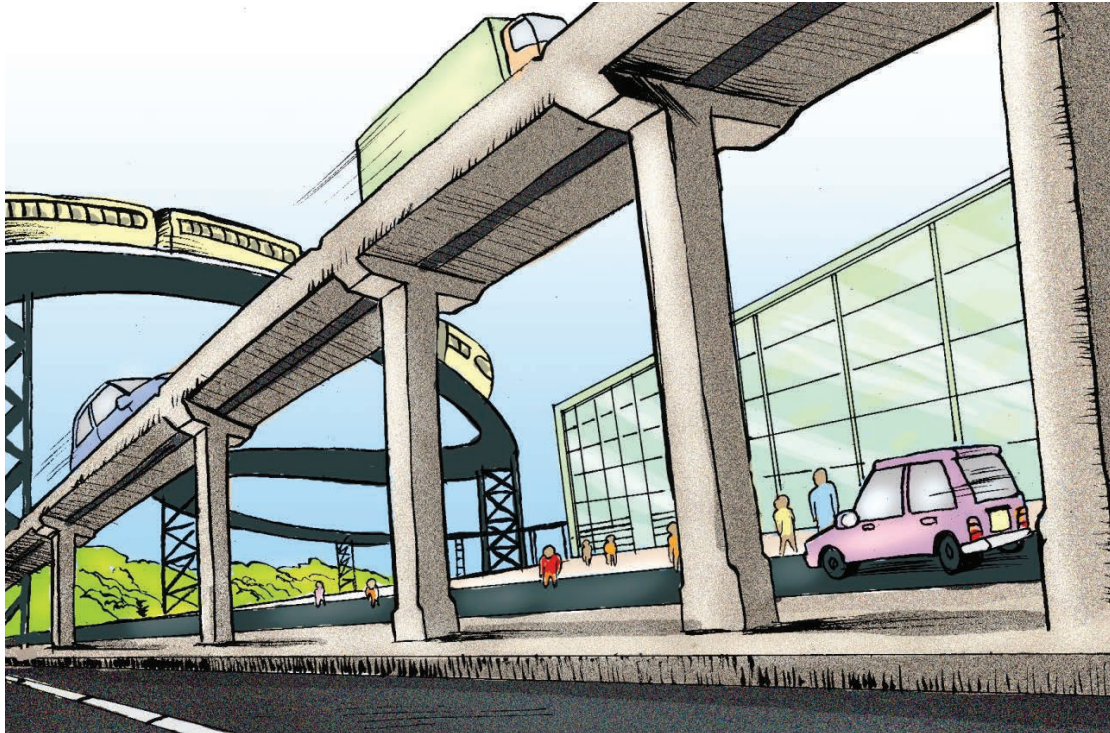


Figure 19. Herd of Zebra: “Together with supporting regional government policy, better road and rail links and other infrastructural improvements have attracted investment from foreign private sector companies, creating employment, new towns and industrial estates.

Livelihoods: a tough new world of opportunities

There has been mass migration to the cities, particularly following the drought in 2020–2022. However, a lack of urban planning and investment has meant the health and quality of life of poor city-dwellers is deteriorating due to inadequate housing, lack of clean water and sanitation, and overcrowded transport systems. The middle classes, in contrast, have enjoyed a sharp improvement in the quality of life.

Investment in agriculture has been encouraged through subsidies and tax breaks, since it is recognized that this sector can deliver good profit due to expanding markets and reduced transport and technology costs. However, the drought accelerated the already rapid exodus of rural people to the cities, with smallholders especially vulnerable to giving up and seeking employment elsewhere. Those remaining on the land have often fallen into debt, and suicide rates have risen sharply. Consumption has increased markedly in urban areas as incomes have risen, although the cost of living rose significantly during and immediately after the drought.

Although wealth distribution has become increasingly uneven as GDP has risen, people living in the EAC in 2030 enjoy better livelihoods on average than in the past. Foreign investment, technology adoption, industrial production, and improved infrastructure and communications have all increased employment opportunities. The better educated have almost invariably found relatively well paid work in the cities. However, many jobs require levels of education that are beyond the reach of the rural poor, who remain disadvantaged and marginalized in the increasingly competitive jobs market.

Private investment has fostered the development of private health care, but this is available only to the swelling middle classes, with the urban and rural poor unable to gain access. Due to a lack of government action on food security and food safety, health issues related to poor nutrition and inadequate food storage and processing are common.

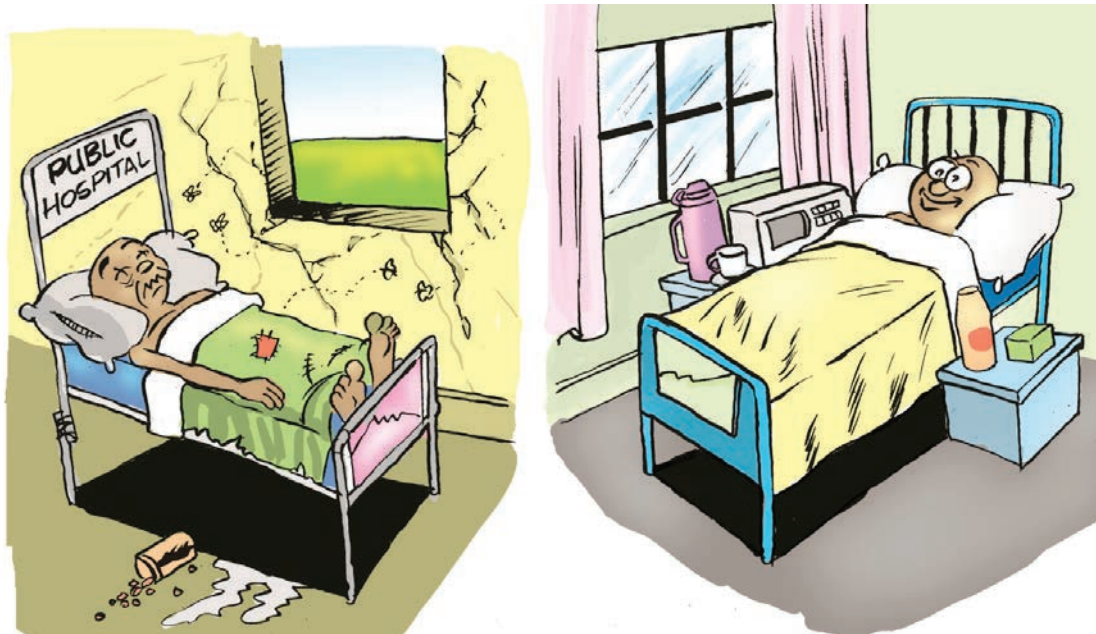


Figure 20. Herd of Zebra: “Private investment has fostered the development of private health care, but this is available only to the swelling middle classes, with the urban and rural poor unable to gain access.”

Agriculture: food production, but not for Eastern Africans

In 2030, the region is experiencing strong growth in agricultural production and productivity, but this is oriented mainly towards export markets. Use of agrochemical inputs has risen and a greater area of land has been put to agriculture, with encroachment into forest and wetland areas. Use of irrigation has also risen markedly, depleting water tables. Many more farmers are working in commercial agriculture than was the case in 2010. Given increased demand from within and beyond the region, livestock production has become more profitable and farmers in areas with good infrastructure are able to invest in improving their pasture by adding fertilizer and using irrigation. However, pastoralists in the more remote drylands have not benefited, in part because they have poorer market access, but also because unreliable rainfall makes investment risky. The intensification of agriculture, particularly through large-scale monocropping, has contributed to an increase in pests and diseases. Meanwhile, governments have been slow to introduce measures to prevent the spread of pests and diseases across the open borders, creating real risks of a pandemic.

The severe drought of 2020–2022 had a devastating effect on agriculture and livelihoods, with a dramatic fall in food production and an increase in food prices. In the short-term the government was able to draw down regional food reserves to feed the hungry and keep food prices more or less affordable. At the same time, the government relaxed import regulations for food products, allowing increased supplies to come into the region. However, as the drought continued, government revenues fell dramatically due to the collapse of large-scale commercial farming and the region was forced to seek food aid.

Many agricultural workers, from large-scale commercial farms as well as from smallholdings, migrated away from rural areas to seek employment elsewhere. This resulted in the rapid growth of towns and cities, with shantytowns springing up without the necessary supporting infrastructure (particularly water and sanitation). Other small-scale farmers left their land and tried to farm elsewhere, adding to the wide-scale environmental degradation, biodiversity loss and destruction of water catchment areas.

Food security: eating money

East African economies' heavy reliance on food imports has left them highly vulnerable to fluctuating global food prices over the past 2 decades, causing recurrent short-term food crises. This is a problem that neither the regional nor national governments have been able to address effectively. Instead, the region has become proficient at obtaining foreign food aid quickly.

On a more positive note, strong industrial growth has raised GDP and, while little attention has been paid to equity and pro-poor development, the growth of regional economies has provided many jobs and helped lift some of the population out of poverty. However, due to the rising population, this has had little effect on improving food security.

Loss of export markets during the drought led to a fall in tax receipts, so national governments had reduced amounts of money to spend on emergency food programmes and safety nets. However, the EAC government, true to its reactive governance style, mustered food aid from its African, European and Asian partners, who swooped in to save the day, at least in the short-term.

Longer term responses were less effective. Despite signing up to regional agreements to support research oriented towards small-scale farmers, few national governments responded to declining food security by introducing available technological improvements. These included new crop varieties and animal breeds that are better adapted to disease and water shortages. These technologies were left on the research station shelf, just as they had been in earlier decades.

Environments: wetland wastelands and savannahs full of cars

In recognition of its high dependence on natural resources for economic growth, the EAC formulated a regional natural resource management strategy as early as 2013. This spelled out the key intervention areas, which included water resource management and the protection and rehabilitation of fragile natural lands. In 2018, the Community formally recognized the need to include climate variability and change in its development planning.

Despite these efforts, which included introducing policies and legislation to address environmental degradation, little attention was paid to building the capacity of the national institutions needed to implement the required actions. The policies and strategies therefore remained on paper. National institutions continued to focus on reactive interventions, working on disaster response plans instead of prevention and preparedness based on region-wide, integrated early warning systems. Such environmental protection measures as were implemented focused almost exclusively on areas important for tourism, which continue to attract a high level of foreign exchange.

By 2030, water shortages have become a major problem, hampering efforts to attain food security. Although regional legislative frameworks are in place, they are not enforced, and water quality and availability have suffered dramatically. In 2020, it became evident that most of the region's lakes were shrinking steadily. Between 2010 and 2020, the level of Lake Victoria fell by approximately 2.5 metres, while Lake Nakuru regularly lost half its surface area for eight months of the year during the dry season.

Transboundary water management agreements were discussed frequently but prompted little action until 2020. Efficiency in the use of water from large basins has remained low. At the same time, pollution is on the up as a result of increasing industrialization, use of agrochemicals in farming, and domestic effluent. Eutrophication in major water bodies has increased, affecting fish stocks and allowing invasive weeds to bloom, while deforestation and poor watershed management have contributed to soil erosion and sedimentation.

Water quality has suffered as a result and treatment costs for drinking water have escalated. Action has been taken only in response to crises, for example when competition for strategic water resources threatens to cause civil strife. Although governments have worked together to control violence across national borders, internal conflicts within countries have been frequent, with a rising number of complaints made to local governments and NGOs. Media reporting on water-related conflicts has followed a similar trend.

Poor water management and increasingly unpredictable rainfall have reduced water availability not just for agriculture but also for industrial and domestic uses. Production costs have risen sharply as a result, forcing farmers and industrialists to invest in water harvesting and recycling. The regional government introduced water taxes but, as with many other regional government initiatives, implementation has been weak and ineffective.

Pollution of the region's rivers has adversely affected coastal fisheries in the Indian Ocean. Fishermen now have to travel further out to sea to find fish, which puts them in competition with the large-scale Asian fishing fleets. In 2020, the sustainable management of the East African coastline became a focus for donor attention, in an attempt to secure the future of fishing as a livelihood and for food security. However, the regional resource management strategy has not been enforced properly, mainly due to falling tax revenues in the wake of the drought. Unsustainable fishing, both small-scale and commercial, along the coast has continued, leading to an alarming loss of marine biodiversity. Deterioration of the marine environment has also adversely affected the tourism industry due to the bleaching of coral reefs off Zanzibar, Mombasa and Pemba.

Meanwhile, the region's soil resources have been badly affected by erosion, declining fertility and contamination with agrochemicals as a result of monoculture, mechanization, improper application of fertilizers and pesticides, and reduction in fallow periods. While civil society and environmental organizations have forced governments to enact laws to protect soil quality, these have not been fully implemented.

In the absence of government policy to protect it, biodiversity is being lost at an accelerating rate (except in the prime tourist areas). Many indigenous plants used as medicines are being overharvested, since they provide an affordable alternative to costly pharmaceutical products. Despite renewed efforts at enforcing regional agreements, the situation has not changed in the ten years leading up to 2030.

By 2025, the region's environmental credentials were so poor that the EU introduced a ban on all EAC products that contributed to environmental degradation, ordering the government to take immediate action to protect the natural environment. The EAC scrambled to follow this request on paper and, for a few years between 2025 and 2027, ambitious plans for more sustainable development began to be implemented. However, in 2027, the ban was loosened considerably. At this point the impetus for reform, never very strong, disappeared completely and the new policies are now falling by the wayside. Only after the Great Drought did the government start to take its watershed management policies seriously, organizing watershed platforms in response to the urgent need for cross-sector dialogue and stakeholder participation in decision making.

On the whole, however, governments continue to 'look the other way', resulting in little effective action on sustainable resource management. In the absence of government leadership, this role has fallen largely into the hands of NGOs and CSOs. These organizations typically work independently with little coordination and sometimes in competition with one another, so the impact of their activities has been very local.

Industrious Ants – a story of strong regional integration and proactive governance

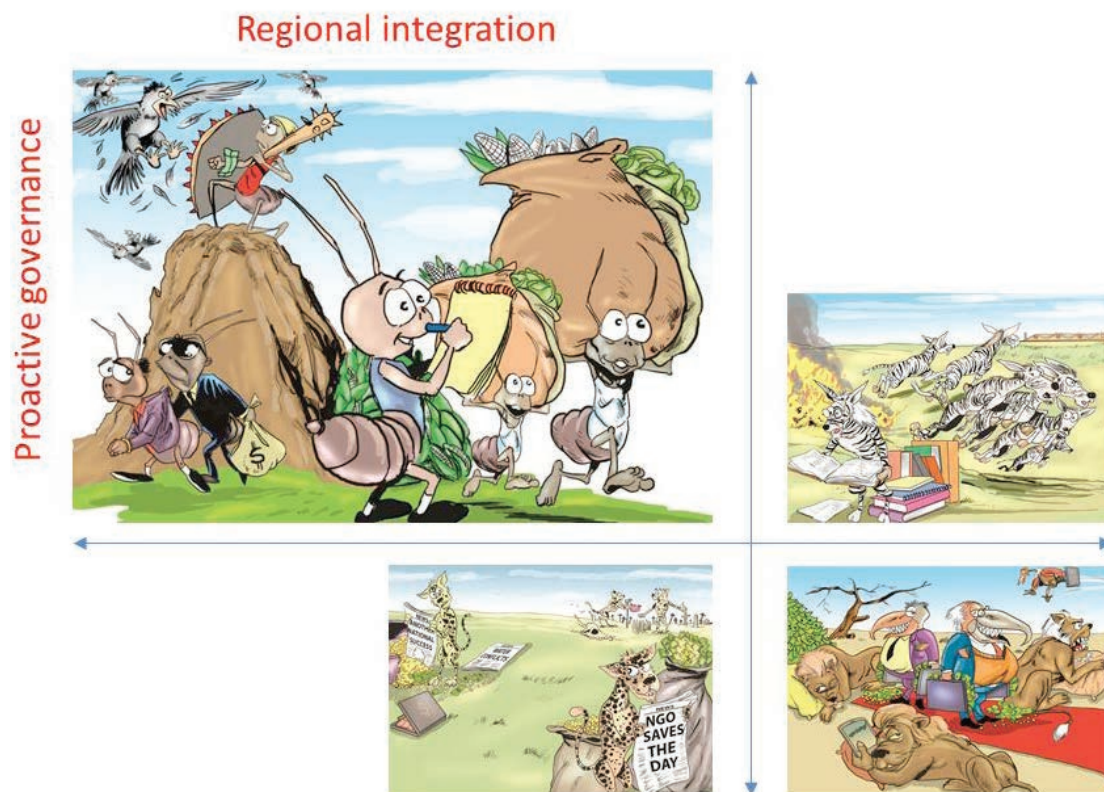


Figure 21. Industrious Ants.

Summary

This scenario features slow but strong economic and political development in East Africa, accompanied by proactive government action to improve regional food security. However, on the down side, costly battles with corruption continue and peace is fragile, since the region has to deal with new international tensions as a result of its growing prominence on the global stage. The region's focus on the production of staple foods, rather than high-value crops for export, undermines its participation in the global market for a time, while an over-reliance on trade within the region causes problems when severe drought hits in 2020. By that time, though, many government and non-government support structures are in place to mitigate the worst impacts. Governments and their partners work well together and achieve some success in mitigating the adverse environmental impacts of increased food and energy production, although the need to put food security and livelihoods first overshadows these efforts from time to time.

Governance: East Africa rising

In 2030, the EAC has eight member states. The five 2010 members (Kenya, Burundi, Rwanda, Tanzania and Uganda) were joined by South Sudan in 2013, Ethiopia in 2018 and Somalia in 2024. The people elected their first East African President in 2022. The region has common customs tariffs and standards for public service delivery that enable greater transparency and effectiveness in trade and government support for development. Although not easy to establish, these have generated balanced economic growth across the member countries, but pockets of stagnation remain in remoter rural areas. Political and economic unification has allowed East African policy makers to stand their ground in international

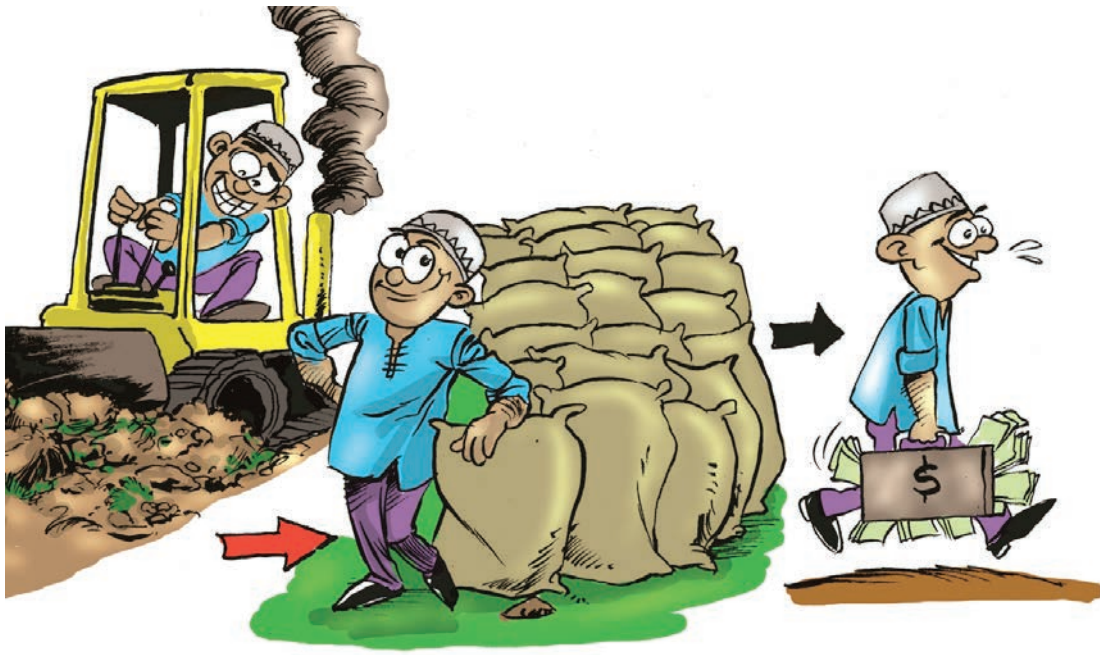


Figure 22. Industrious Ants: “In general, the quality of life for many East Africans has improved as a result of the larger regional market for agricultural commodities.”

negotiating forums. In general, the quality of life for many East Africans has improved as a result of the larger regional market for agricultural commodities, the emphasis on value-added production, the production of competitive goods for international trade, and greater domestic and foreign investment.

Kenya took the lead in laying the foundations for a strong and stable democracy by completing a constitutional review process in 2011, which made provision for freedom of the press, among other reforms. Other member states have followed suit. Meanwhile, improved transparency and accountability in the region’s leadership have been reflected in more democratic elections and reduced potential for electoral disputes and violence. Further illustrations of the region’s proactive governance are found in the independent regional judicial system, established in 2018. A disciplined security system is now in place, following a 2017 review process that emphasized professionalism and offered good remuneration packages for military and police personnel. Enhanced security has benefited the economy by enabling the free movement of goods and services within the region. However, corruption scandals continue to surface more often than the region’s leaders would like, and the fight against corruption drains funds and saps political will. Taking a proactive approach to regional governance has enabled the EAC to keep political instability to a minimum. At the same time, serious national and regional conflicts over natural resources have seldom been in the news.

A further advance towards political and economic integration took place in December 2020, when the EAC created a monetary union using the East Africa shilling as a common currency. After a bumpy start, this currency proved relatively stable compared to national currencies. Economic integration has allowed uniform trade tariffs for imports into the EAC, resulting in a significant increase in the volume of traded goods. Financial integration was expanded in 2025 to include the listing of publicly traded companies on a regional stock exchange, based in Kampala, Uganda. By 2022, the region had developed common policies on trade and investment, enabling the business community to take full advantage of investment from Asian companies. This has led to growth, particularly in the processing of agricultural outputs, as well as in communication and information technology. During the 2020s, trade agreements

were signed with several fast-growing economies, including Brazil, China, India, Russia and South Africa, as well as with other regional blocs. To avoid repeating the historic difficulties of the Euro zone, EAC countries also harmonized fiscal, taxation and welfare regimes to a great extent.

In 2030, citizens are free to travel between EAC countries without visas or work permits. The free movement of labour has expanded employment opportunities, improved household incomes and raised the quality of life, especially for the better educated. Uniform social security policies have ensured migration occurs mostly for work. While some countries have gained from economic migration (e.g. Tanzania has benefited from an influx of well-educated Kenyans), others have fared less well. And urban areas have benefited more than rural ones: such professionals as doctors, teachers and scientists have gravitated to the major urban centres of Nairobi (Kenya), Dar es Salaam (Tanzania) and Addis Ababa (Ethiopia), where standards of education, training and health have risen sharply and investments in science have generated a marked increase in the prominence of Eastern African research. However, governments' capacities to deal with the challenges posed by greater freedom of movement have developed only recently. In the early days of the EAC, the law had only limited penetrative power in rural areas and lacked a strong grip on issues of international security and corruption. During recessions, there were some ugly outbreaks of racism as people turned against immigrant communities.

The importance of agriculture to food security, poverty reduction and economic growth was recognized in a regional agriculture and rural development strategy, finalized in 2019. This outlines the strategic interventions needed to accelerate the sector's development and includes plans for research and extension, water storage and irrigation, market development and early warning systems for extreme weather events and natural disasters. As part of the strategy, strong trade-related phytosanitary regulations were adopted in 2020. Although costly to institute and manage, these limit the potential for the spread of diseases, pests, viruses and weeds between countries and hence work in favour of regional food security. Meanwhile, member state governments united in voicing a strong commitment to poverty reduction as their number one priority in 2024.

Infrastructure: fast train to work

Successful regional integration has spurred the development of infrastructure, with fast roads and railway lines linking the major cities, first in Kenya and Uganda and later elsewhere. Despite protests from conservationists, Kenya's main port has been moved from Mombasa to the new deep-sea port at Lamu to cope with the demand for imports.

Advances in information technology, including the installation of fibre optic cables, have reduced communication costs, while regional TV stations now advertise and create demand for products among a wider audience than ever before. Access to market intelligence via mobile phones has enabled farmers to get better prices for their produce.

By 2020, the EAC had a regional power supply grid with all major towns and cities on mains electricity, supplied largely by coal-fired power stations. By 2030, wind and hydroelectric power is also being generated. Rising demand for biofuels has led to the establishment of pilot biofuel refineries in Kenya and Ethiopia. The down side of this development is the need for large areas of productive agricultural land and the associated impact on regional food security.

The modernized infrastructure has attracted foreign investment, with multinational companies from the North developing subsidiaries in the EAC, thereby boosting employment

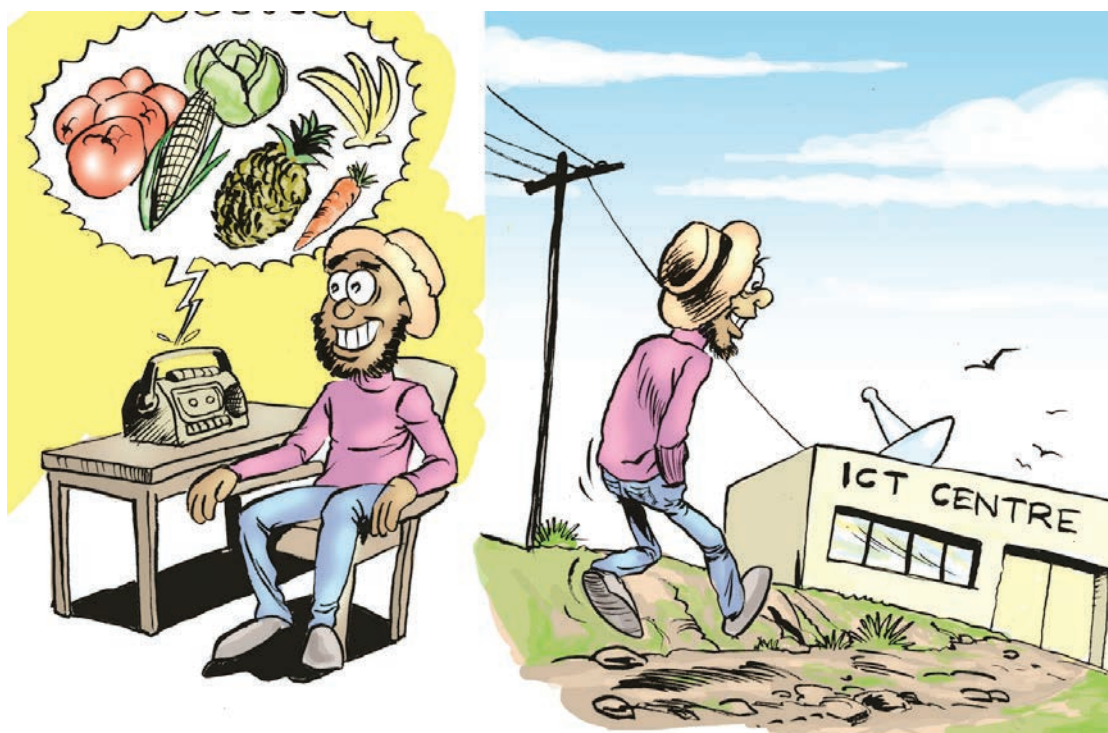


Figure 23. Industrious Ants: “Advances in information technology, including the installation of fibre optic cables, have reduced communication costs, while regional TV stations now advertise and create demand for products among a wider audience than ever before.”

opportunities. More efficient information systems and e-commerce have also contributed to the region’s strong economic growth. However, while young, educated city dwellers are finding work, people in the rural areas and urban slums, who lack technical knowledge, have been left behind as the ‘digital divide’ has deepened.

Livelihoods: governance for opportunities

A large proportion of the people living in the EAC have seen their livelihoods improve over the past 20 years due to the growing economy. However, there is still acute inequality in wealth distribution. Rising land prices and the introduction of new technologies have prompted many to leave the agriculture sector and take up employment in urban areas. As a result, agricultural labour has become scarcer and more expensive. The population is now much more mobile and people are more willing to move to take up job offers. This has severed traditional community ties and reduced social cohesion.

Now that governments have invested in agriculture and information technology, agricultural extension services and weather forecasters are able to provide early warnings to farmers on impending droughts and floods, together with information to help them plant, harvest and market their produce in order to maximize their profitability. There is improved access to private health care for some, due to investment in health service provision by the private sector. Government action has focused on disease prevention, while general health care remains underfunded. The urban poor cannot afford private health care, but state-managed hospitals are understaffed and poorly equipped. Meanwhile, commercial farms have invested in knowledge and skills development, as well as health facilities, for their employees and their families as part of their growth strategies. This has had the effect of improving health care in rural areas.

Availability of credit has also increased as a result of private sector investment, with an increase in the number of financial service providers. Smallholders are able to obtain credit to invest in cash crops and livestock and hence lift themselves out of the subsistence trap, but many are still highly vulnerable to crop failure and payment default, which can drive them deeper into poverty, rendering them unable to pay the rent or even forcing them to sell their land. Medium- and large-scale commercial farmers find it easier to benefit from increased availability of credit, which enables them to invest in new technologies that will increase productivity and efficiency.

Agriculture: food for East Africans

By 2015, most countries in the region had invested 10 percent of GDP in agriculture, in line with the 2003 Maputo Declaration. This improved farmers' access to enhanced production technologies, affordable credit and market information. Investments were also made in irrigated agriculture and food processing industries. Meanwhile, existing regional agreements on extension, research and innovation, credit, agroprocessing and marketing were strengthened. The processing sector also created employment opportunities, with positive effects on food and livelihood security.

Agriculture in East Africa has received a tremendous boost during the past ten years, following expanded market opportunities within the EAC itself. However, despite investment in agricultural research and extension, some areas remain highly vulnerable to crop failure, particularly in the face of increasing climate variability.

In high-potential areas, farm operations have become more specialized. Increasing returns to farming have led to a steep rise in the cost of land. As a result, smallholders with less than 1 hectare, who need all their land to feed the family, find themselves locked out of expanding markets. Those who can make the necessary investments in land and other resources increasingly specialize in cash crop and livestock production to meet the demands and standards of the global market. Productivity has increased following the broad-scale adoption of new agricultural technologies. While jobs have been created, increasing mechanization has displaced many farm labourers and subsistence farmers, with many young, educated rural people migrating to urban areas while the less well educated stay put but are forced to rely on seasonal jobs on commercial farms. However, better access to market intelligence has allowed farmers, especially the more entrepreneurial smallholders, to respond to new opportunities and adapt to market forces.

Overgrazing and climate change have reduced the carrying capacity of many pastures, and some areas have been abandoned. Many pastoralists have had to give up their traditional way of life, although governments are supporting pastoralists' livelihoods through subsidies. However, there has been a shift to more intensive peri-urban livestock production systems to meet the increased demand for livestock products from a wealthier urban population. In fact, aided by a new regional livestock market information system, the EAC has been exporting livestock products to the Arabian Peninsula and North Africa in ever increasing quantities additional to already well-established trade with these regions. A regional steering committee on transboundary animal diseases, formed in 2020, has contributed to improved livestock health and productivity.

Climate change has had a wide range of impacts on ecosystems, putting water and grazing resources under extreme pressure. Investment in water infrastructure, especially small dams, has allowed irrigated agriculture to expand, but the increasing frequency of drought poses a growing threat to the stability of agricultural and ecological systems. The warmer temperatures have allowed food crop yields to rise in the highland areas, but higher evapotranspiration in the arid and semi-arid areas has led to productivity declines.

Considerable support from the Global Climate Change Adaptation and Mitigation Fund for the development of carbon-neutral ‘conservation agriculture’ has boosted agricultural productivity on smallholdings. To date, farmers and consumers in Kenya, Tanzania and Uganda have benefited the most from this new approach, which is gradually spreading throughout the region. Generally, better education, information and access to credit have allowed smallholders to be more proactive in the face of climate change, but the poorest are still highly vulnerable.

In 2015, prompted by growing global demand for food and stronger lobbying from East Africa, the reinvigorated World Trade Organization (WTO) made a major breakthrough when it oversaw the removal of trade barriers in developed countries (notably the European Union) and an increase in trade subsidies to developing regions. As a result, agricultural output from African countries became increasingly competitive. Exports of such cash crops as coffee, tea, cashew, coconut and sugarcane were boosted by regional policies and subsidies. By 2030, these initiatives had begun to generate impressive foreign exchange earnings, thereby increasing the purchasing power of the EAC’s commercial farmers. Of course, these gains depended heavily on the level of demand from global markets, which remain unpredictable due to the integrated nature of the global economy. Periodic collapses in specific markets have been offset by overall gains, but farmers in affected sectors have suffered losses. For example, during the drought years, when the common currency was weaker, farmers exporting coffee received a windfall; but by 2028 there was a glut on the world market and prices fell abruptly.

Food security: dependence, independence, interdependence

National food security, in the sense of availability, has taken a high priority in EAC development plans since 2015, but this political will has not always been translated into radical changes on the ground, with some communities still living with a constant threat of hunger.

Due to its proactive governance stance, the EAC has attempted to keep a balance in the region’s agricultural production. There has been a concerted effort to expand the production of such traditional crops as sweet potatoes, indigenous vegetables, cassava and yams, at the same time as increasing the yields of cereals and cash crops.

Strong national agricultural research programmes have ensured farmers can access the inputs, including certified seeds, and the training they need to grow improved varieties of traditional crops, some of which have been bred for improved nutritional value as well as better resistance to pests, diseases and adverse climatic conditions. The devastating drought of 2020–2022 had far-reaching effects on food security and the region’s economy. The EAC had established grain reserves in 2018, with assistance from the United Nations’ Food and Agriculture Organization (FAO) and the World Food Programme (WFP), and these were sufficient to feed the population during the first and second years of the drought. However, the region needed external support in the form of emergency food aid and imports from the global market during the third year. Severe malnutrition and deaths were avoided, with only 100 deaths reported in comparison to 4 500 when a similar drought struck in 2000. Larger regional grain reserves for key cereals such as maize and wheat were established in 2023 to protect against similar events in the future.

Biosafety and food safety standards have improved, with effective measures put in place to protect consumers from aflatoxins in grain and unsafe meat and meat products. Urbanization and foreign investment have led to a growth in the consumption of processed food, with an increasing number of junk food restaurants linked to rising levels of obesity and diabetes among wealthier urbanites. However, this trend is moderated by strong government health regulations.

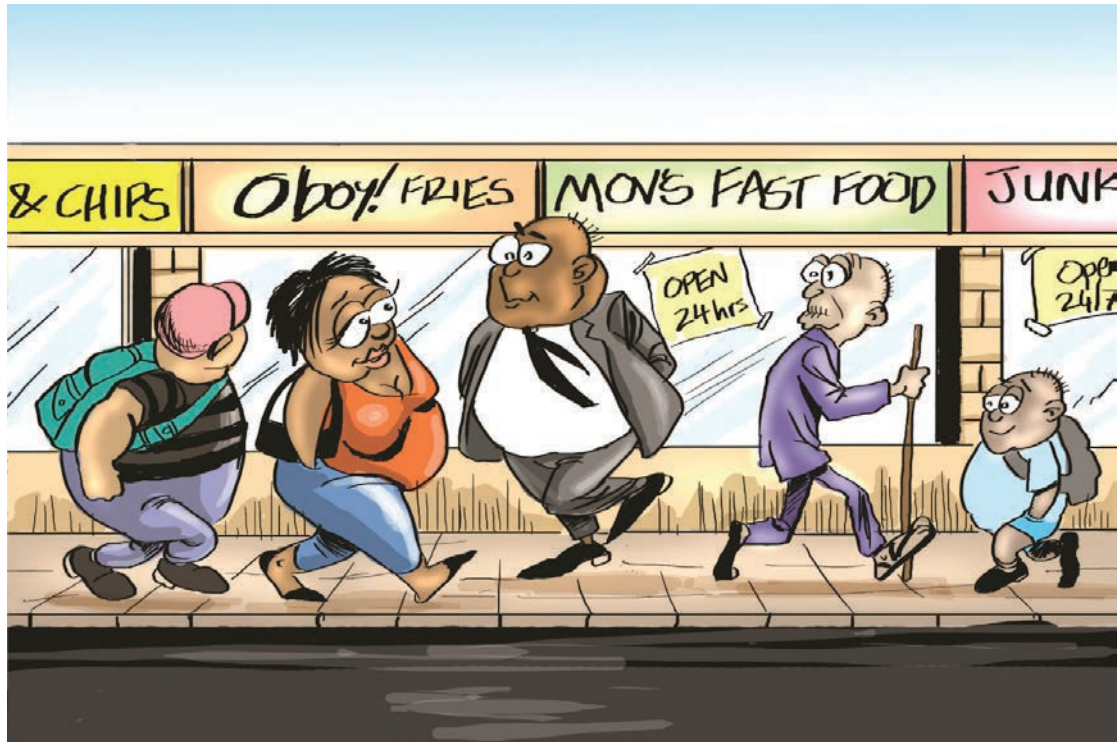


Figure 24. Industrious Ants: “Urbanization and foreign investment have led to a growth in the consumption of processed food, with an increasing number of junk food restaurants linked to rising levels of obesity and diabetes among wealthier urbanites.”

Environments: struggling with trade-offs

Agricultural expansion has put pressure on natural resources, particularly soil, water and forests. Recognizing the critical role played by natural resources in economic development, the region’s leaders began negotiations on their sustainable management in 2010. By 2018, they had made considerable progress in streamlining national policies regarding the management of forests, water and minerals. For example, regional initiatives were put in place to increase the area of land under forest, promote soil and water conservation, control the parasitic weed striga and prevent the transboundary spread of human and livestock diseases. By 2025, the EAC had overseen the reforestation of 15 percent of previously degraded forest areas, benefiting from global climate change mitigation funds.

Transboundary water resource management took a step forward with management agreements for the Lake Victoria basin being established in 2015 and for the Nile Basin being fully implemented by 2025. These agreements enabled member countries to abstract water and expand the area under irrigated agriculture. However, the Lake Victoria fishing communities have been largely overlooked in drawing up these agreements and they have yet to see any benefits.

Water consumption has increased markedly due to increased irrigation and rising demand from urban populations and industries. However, this growth in consumption is now slowing due to the use of more efficient irrigation and industrial water-use technologies, while good water governance has improved the availability of water. Perhaps more importantly, agricultural, domestic and industrial water-use efficiency has improved. Pricing schemes for water are in place and enforced, with water utilities investing their income in improved water infrastructure. There has also been a fall in the number of prosecutions for water pollution, paralleled by an increase in the success rate of such prosecutions.

During the 2020s, marine fishing livelihoods suffered, following protracted disputes with Mozambican and Asian large-scale fishing enterprises and attacks by Somali pirates. By 2030, now that Somalia has joined the EAC, the attacks have diminished due to effective actions of a regionally coordinated marine policy force.

The effects of agricultural intensification on natural resources have been buffered by a focus on sustainability in new technology development and dissemination. Deforestation is being brought under control through proper enforcement of forest management law, but there has still been some soil loss in forest areas as cropping expands into steeper hillside areas and rainstorms intensify as climate change takes hold. Replanting under the United Nations REDD programme, supported by regional agreements with NGOs, has also reduced net deforestation. While the use of agricultural chemicals has risen, water pollution regulations came into full effect in the 2020s and new integrated pest management technologies have reduced the need for pesticides. Regulations on the conversion of land for agriculture succeed in preventing the loss of valuable wetland habitats in all but a few locations. Other types of land conversion, such as human settlement, have contributed minor amounts of soil erosion and carbon depletion.

In many rural areas, the pressure to convert marginal and protected land to commercial agriculture has threatened to become irresistible. In general, however, strict law enforcement has halted such agricultural expansion in many places and regional biodiversity has maintained to some extent. Local by-laws and user associations are backed up by national government and regional policy, which has overseen the return of much forest land to local community management. There has been a marked reduction in the number of people being prosecuted for illegal poaching, logging and grazing in protected areas.

Quantifying scenarios: semi-quantitative indicators

Once scenario narratives had been generated, participants described what these scenarios meant for a set of indicators. This set of indicators was generated by participants to represent what they considered to be the scope of interest associated with food security, environments and livelihoods. Participants proceeded to indicate what they thought were the directions and magnitudes of change for each indicator over multiple time steps, and provided the logic for these changes from the relevant scenario.

The following indicators were outlined on a scale of -3 to +3 using descriptions of the logic for change:

- GDP
- corruption
- political stability
- infrastructure development
- urbanization
- yields of rainfed crops
- yields of irrigated crops
- area of rainfed arable land
- area of irrigated arable land
- livestock numbers
- livestock yields
- agricultural input costs
- nutrition
- dietary diversity
- poverty
- equity
- access to health care
- forest cover change
- biodiversity

The required inputs for the IMPACT and GLOBIOM models were among this list of indicators. By outlining semi-quantitative assessments of change, the scenarios process participants provided information for the conversion of the scenarios assumptions into quantitative model drivers.

The tables below (1 to 4) provide semi-quantitative information about the developments of a number of indicators for economy and governance, food production and food security, livelihoods and environments for the 4 scenarios for Eastern Africa. Care was taken not just to specify the direction of change in each variable, but also why each change happened. Capturing the logic behind each change helps interpret further analyses using the scenarios as well as the quantitative model outputs.

The consistency between changes in different indicators was also reviewed with the stakeholders while developing these assessments of directions of change.

Table 1. Economy and governance indicators.

Indicator	Industrious Ants		Herd of Zebra		Lone Leopards		Sleeping Lions	
	2020	2030	2020	2030	2020	2030	2020	2030
Gross Domestic Product	+	+++	++	+++	++	++	++	+
Why?	Broad development push for food security, environments, livelihoods		Focus on industry, services, tourism, export agriculture		Profitable bilateral arrangements but differences between sectors and countries		Unproductive collaboration with external actors; lack of regional institutions	
Corruption-free institutions	+	++	--	--	--	--	---	---
Why?	Regional collaboration takes time to become effective		New regional institutions become vehicles for corruption		Failures as well as successes but lack of coordination		Lack of regulations	
Political stability	++	+++	-	+	--	--	--	--
Why?	National issues have to be worked out first		Some initial conflicts over resources, later solved		Conflicts over resources; trade		Ineffective governance; no collaboration	
Infrastructure	+	+++	++	+++	++	++	++	+
Why?	Long-term investment		Investment for industry		Patchwork improvement		Solely due to outside investment – but difficult due to lack of support	
Urbanization	++	+++	+++	+++	+++	+++	+	++++
Why?	Not extreme because of rural investment		Urbanization responds to investment sectors		Urbanization responds to investment sectors		Lack of rural livelihoods	

Table 2. Food production and food security indicators.

Indicator	Industrious Ants		Herd of Zebra		Lone Leopards		Sleeping Lions	
	2020	2030	2020	2030	2020	2030	2020	2030
Yields of rainfed crops	++	+++	+	+	+	++	--	--
Why?	Effective support (tech and skills)		Not a government priority		Last decade sees NGO/CSO support		Environmental degradation; failing support	
Yields of irrigated crops	++	+++	++	++	++	++	+	+
Why?	Investment in production for regional consumption		Investment in export agriculture		Investment in export agriculture		Marginal increase for export crops	
Area of rainfed arable land	+++	++	+++	+++	+++	++	+++	+++
Why?	Attempts to moderate expansion		Smallholders expand uncontrolled		Some mitigation of expansion by state/non-state partnerships		Drive by need for food security	
Area of irrigated arable land	+++	++	+++	+++	+++	++	++	+++
Why?	Attempts to moderate expansion		Export agriculture		Some mitigation of expansion by state/non-state partnerships		Only export crops produced by external actors	
Livestock numbers	+	0	+	++	-	++	+	+
Why?	Policies to mitigate livestock impacts		Pastoralists decline under pressures; number of poultry grows		Pastoralists decline under pressures; number of poultry grows		Pastoralists decline under pressure; some poultry	
Livestock yields	+	++	++	++	++	++	+	+
Why?	Investment in different animals, actors, production systems		Ruminants decline but poultry grows		Ruminants decline but poultry grows		Marginal tech investment in poultry	
Agricultural production cost improvements	+	++	++	++	--	+	---	---
Why?	More fair and transparent pricing		Rising fuel costs; ineffective governance		Rising fuel costs; state/non-state partnerships have positive impacts later		Rising fuel costs; artificial raising of prices	
Nutrition	++	+++	+	+	-	++	---	---
Why?	Focal point for government policies		Benefits of development spread unequally		Food security partnerships form in the last decade		No efforts to mitigate; communities' expertise grows	
Dietary diversity	++	++	++	++	No change	++	---	--
Why?	Focal point for government policies		Benefits of development spread unequally		Food security partnerships form in the last decade		No efforts to mitigate; communities' expertise grows	

Table 3. Livelihoods indicators.

Indicator	Industrious Ants		Herd of Zebra		Lone Leopards		Sleeping Lions	
	2020	2030	2020	2030	2020	2030	2020	2030
Poverty improvements	++	++	+	+	--	+	--	---
Why?	Broad development push for food security, environments, livelihoods		Benefits of development spread unequally		State/non-state partnerships become effective		Little support from state/non-state actors	
Equity	--	--	--	--	--	--	---	---
Why?	Equity decrease with rising GDP		Equity decrease with rising GDP		Differences between countries but overall decrease with rising GDP		Little support from state/non-state actors	
Access to health care	+	++	+	+	No Change	++	--	--
Why?	Broad development push		Benefits of development spread unequally		State/non-state partnerships become effective		Little support from state/non-state actors	

Table 4. Environmental indicators

Indicator	Industrious Ants		Herd of Zebra		Lone Leopards		Sleeping Lions	
	2020	2030	2020	2030	2020	2030	2020	2030
Forest conservation	---	--	---	---	---	++	---	---
Why?	Governments/ NGOs struggle with environmental governance		Ineffective environmental governance		Mobilization of regional and international NGOs		Environmental degradation unmitigated	
Biodiversity	---	--	---	---	---	+	---	---
Why?	Governments/ NGOs struggle		Ineffective environmental governance		Mobilization of regional and international NGOs		Environmental degradation unmitigated	

Quantitative analysis of the scenarios

The stakeholder-driven scenarios presented in the previous section have been translated into a number of semi-quantitative indicators through directions and logics of change provided by the regional stakeholders. These assumptions were made on the basis of the scenario narratives. A set of these semi-quantitative indicators have been used to provide inputs for full quantification of the scenarios through 2 global agricultural economic models IMPACT (Rosegrant et al. 1995, Rosegrant 2012) and GLOBIOM (Havlik et al. 2011). These models have been used to generate information about select long-term consequences of the stakeholder-generated scenarios. They also allow stakeholder assumptions about regional socio-economic change to be put against top-down, long-term global socio-economic projections such as future global food demand.

Through an iterative process, the results from both models for East Africa were discussed with regional actors to ensure that they were plausible, relevant and challenging for the regional context and consistent with original scenarios. The challenge of combining stakeholder generated scenarios and scenarios as model outputs is that the models are limited in the flexibility of their basic assumptions as to what futures they can explore and focus more on the ‘known unknowns’. The scenarios process facilitators therefore take care to point out the models’ limitations and the differences between the models’ basic assumptions to prospective users. This is the benefit of such an ‘ensemble approach’ – using multiple models offers a more diverse perspective on plausible futures and underlines the value of engaging with uncertainty.

Model descriptions

GLOBIOM

IIASA developed and uses GLOBIOM to provide insight for global land use competition by integrating the major land-based production sectors: agriculture, bioenergy and forestry. GLOBIOM can be used in scenarios analysis to assess how socio-economic development resulting from different governance and policy strategies affect not only the agricultural sector through food availability but also the environment through deforestation by area growth in pasture and crop land. The model accounts for changes in supply and demand for 20 globally important crops, livestock production activities, major forestry commodities, and multiple bioenergy transformation pathways using a detailed representation of each sector. The model is spatially explicit and accounts for all major land use types in terms of production. Demand for agriculture, bioenergy, and forestry products is determined for the 30 regions within GLOBIOM. Trade is modelled under the homogenous good assumption and where optimal bilateral trade-flows result from the minimization of the international trade costs, which include tariffs and transportation costs (Takayama and Judge 1971). GLOBIOM has been widely used for understanding the effects of policies on global land use and associated GHG emissions. Studies have examined the effects of regional policies on global land use for bioenergy (Frank et al. 2013, Mosnier et al. 2013) and the trade-off effects of improved crop productivity on food security, the livestock sector, and GHG emissions (Havlik et al. 2013b, Valin et al. 2013).

IMPACT

IFPRI developed and uses IMPACT to provide long-term scenarios for the global agricultural sector. It can be used in the development of regional scenarios to focus on the countries of a region, their interactions with the world through trade, and how this relates to agricultural

production. IMPACT models global trade through world prices for 44 commodities and livestock products which are determined by the domestic supply and demand of the 115 regions. IMPACT is a partial equilibrium model with thematic focuses on water demand and availability as well as the effects of climate change on limiting crop yields and area potential. IMPACT has been widely used in food security scenarios analyses including the *Global Food Projections to 2020* (Rosegrant et al. 2001) and more recently with a commodity investment study in *Food Security, Farming, and Climate Change to 2050* (Nelson et al. 2010), as well as regional analyses on climate effects on agriculture in *West African Agriculture and Climate Change* (Jalloh et al. 2013) and *Southern African Agriculture and Climate Change* (Hachigonta et al. 2013).

Drivers

Drivers used as inputs into both models were based on interactions with diverse regional stakeholders involved in the CCAFS scenarios process, who provided semi-quantitative assessments of these drivers of change and the assumptions behind those assessments. Once the first model outputs were generated based on these inputs, representatives of the participants in the process were able to criticize the results on their plausibility and usefulness for the region, after which subsequent iterations of the model runs were done.

Population

Population growth projections follow the medium variant growth projections from the UN population database 2010 revision (United Nations Population Division 2010). This growth in population is assumed to be the same for all scenarios and also between the models. In East Africa from 2010 to 2030, population is projected to grow by more than 60 percent, exceeding 360 million by 2030 (Figure 25). Globally, population is projected reach 8.2 billion people, an increase of 21 percent from 2010 to 2030.

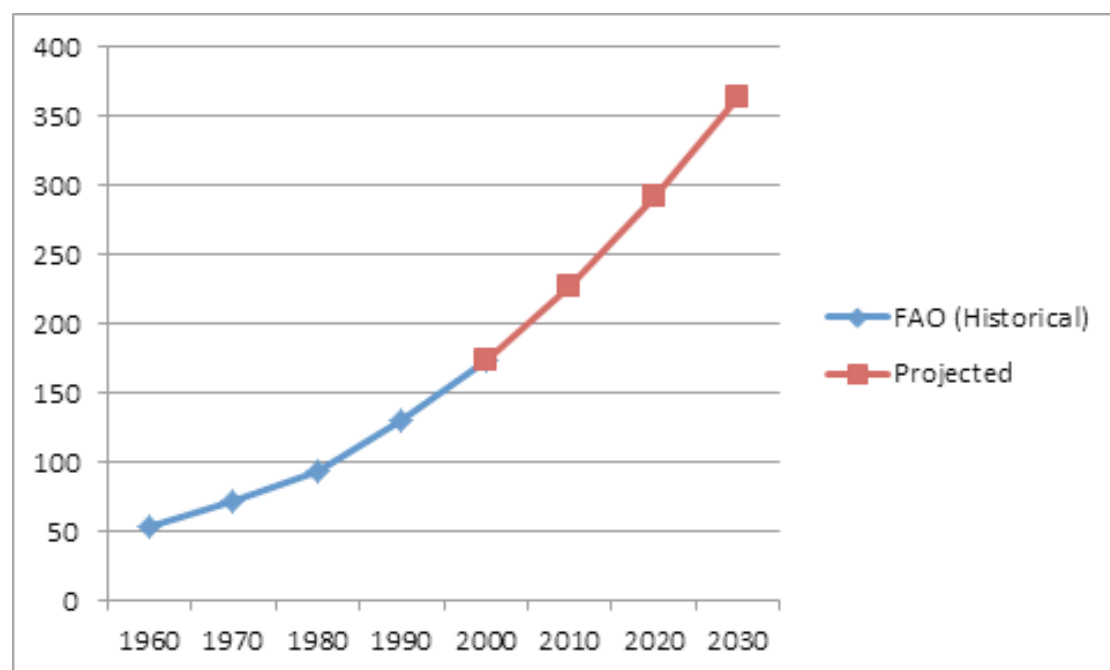


Figure 25. Population projection for East Africa in millions of people from the UN population database, 2010 revision (United Nations Population Division 2010).

Gross domestic product

Figure 26 shows the regional GDP for the 4 scenarios from 2010 to 2030 that was used in the simulations with the 2 models. These GDP projections follow the narrative assumptions, based on historic GDP and using IFPRI's *Food Security, Farming, and Climate Change to 2050* (Nelson 2010) scenarios analysis as a plausibility envelope. Industrious Ants, Herd of Zebra and Lone Leopards have similar GDP projections, while the regional GDP for Sleeping Lions is much lower.

The rates of GDP growth throughout the period are similar for the first three scenarios but the way in which the growth is achieved differs for each narrative. The GDP for Industrious Ants reflects the notion that this scenario features not so much a run of quick development but a slow and structural set of investments in broad goals around food security, environments and livelihoods. The GDP for Herd of Zebra reflects the assumption that East Africa in this future world pushes strongly for GDP-oriented economic development, but issues around food security and livelihoods for the poor are neglected and this hampers growth – though this scenario still has the highest GDP of all 4.

In the Lone Leopards world, regional economic development is fragmented in magnitude and character, with a number of activities focusing on proactively improving food security, environments and livelihoods but with other activities, driven by multinationals, following a profits-only industrialization model. However, since there is a lack of institutional support and few attempts to integrate economies, regional economic development stays somewhat lower.

In the Sleeping Lions future, because of a lack of action by state and non-state actors toward long-term economic development, GDP is much lower than in the other futures. Foreign private sector actors come in to make quick profits, contributing significantly to GDP, but these are not long-term investments. The lack of government support and infrastructure for investment further contributes to this relatively low GDP increase. In GLOBIOM, demand for crops and livestock products as well as wood products are driven by increases in GDP in addition to growth in population. Demand for crops and livestock products are also driven by increases in GDP and population for IMPACT as well.

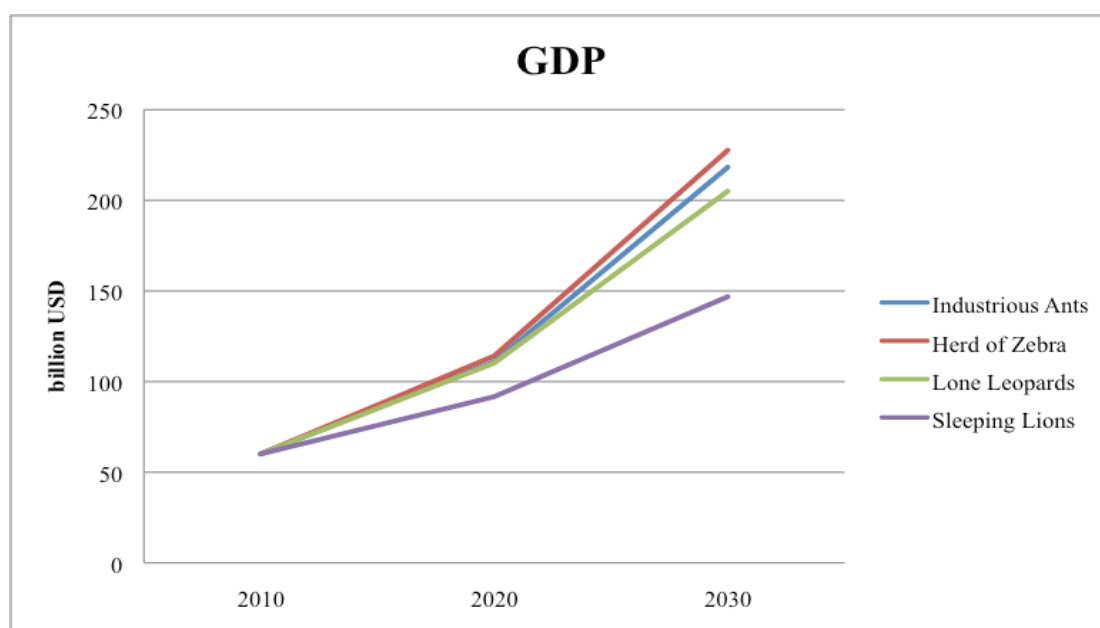


Figure 26. Regional GDP for the 4 scenarios 2010–2030.

Production costs

Regarding production costs, GLOBIOM finds a market equilibrium solution by maximizing the consumer and producer surplus under market conditions and resource constraints. Producer surplus takes into account the various costs of production. These have been included in the scenarios by inferring that the different quality of governance and levels of regional integration in each scenario have implications for the production costs for farmers. Industrious Ants represents a future where proactive governments develop a regionally integrated market structure that results in a relative decrease in production costs by 2030. In Herd of Zebra, reactive governments are slow to respond to regional issues but eventually stop increases in production costs. In Lone Leopards, infrastructure and government instability raise production costs, but strong action by NGOs and the private sector eventually lowers production costs somewhat later in the period. For the Sleeping Lions scenario, infrastructure and government instability raise production costs for all crops in the period.

For the purposes of this analysis, IMPACT does not take into account changes in the costs for producers.

Crop yields

Each scenario has different consequences for technological improvements on crop yields. In the Industrious Ants scenario, investments focus on staple foods for regional consumption. In the Herd of Zebra scenario, attempts at such investments are less effective and therefore the yields are not as high. The Lone Leopards scenario sees stronger investments in technological improvements for the yields of export crops. Finally, in Sleeping Lions, overall technological improvements on yields are limited, and also mainly focused on export crops. While crop yields in IMPACT include the technological improvements underlying the scenarios, yields may also be affected by a crop's own price and the price of other crops. In GLOBIOM, yields follow a pattern of growth in keeping with historical trends as well as including the improvements in yields specific to each scenario.

Crop production systems

GLOBIOM defines crop production systems as high input, low input, subsistence, and irrigated. IMPACT summarizes the crop production systems in 2 categories: irrigated, and rainfed. Figure 27 and Figure 28 illustrate the compositional change in harvest area over the time period for each of the 4 scenarios. The storylines discuss the impact of shifts in production and these can be seen in moving crop production from subsistence agriculture into high and low input production and also the switch from low input to high input agricultural production. The increase in irrigated agriculture is also addressed by the scenarios narratives and presented in an increase in area for all scenarios, but most significantly for the Lone Leopards and Sleeping Lions scenarios.

Livestock numbers, yields and production systems

GLOBIOM and IMPACT characterize livestock production into 4 large species groups: bovines, small ruminants, pigs, and poultry. The classification for livestock production takes into account the agroecological zone, the intensity of livestock production and feeding methods adapted from Seré and Steinfeld (1996). Increase in intensification or extensification and feed substitutions are ways in which the model allows for shifts between production systems. In the Industrious Ants scenario analysis, GLOBIOM simulates the share of bovines

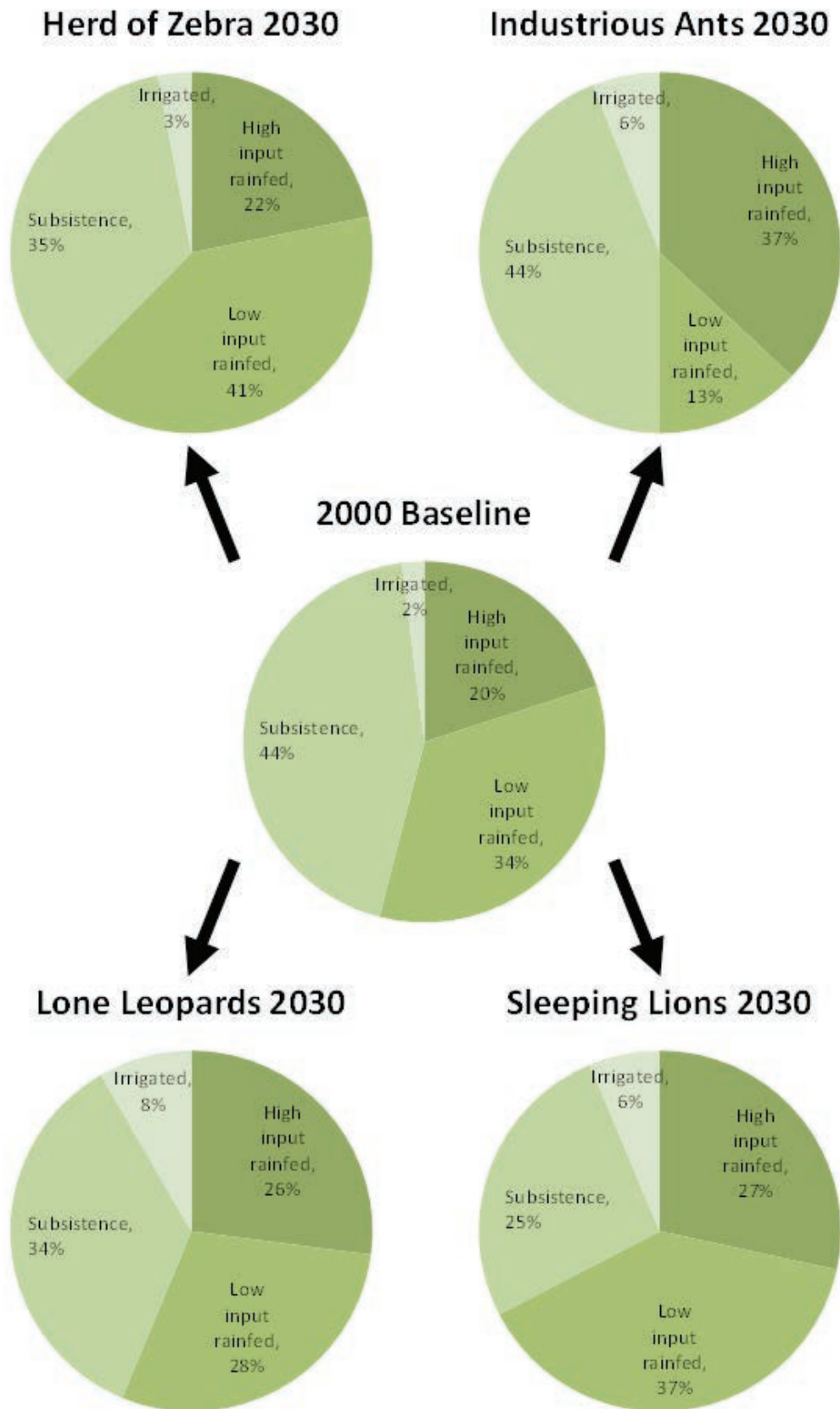


Figure 27. Crop production systems in 2000 baseline, and for each scenario in 2030.

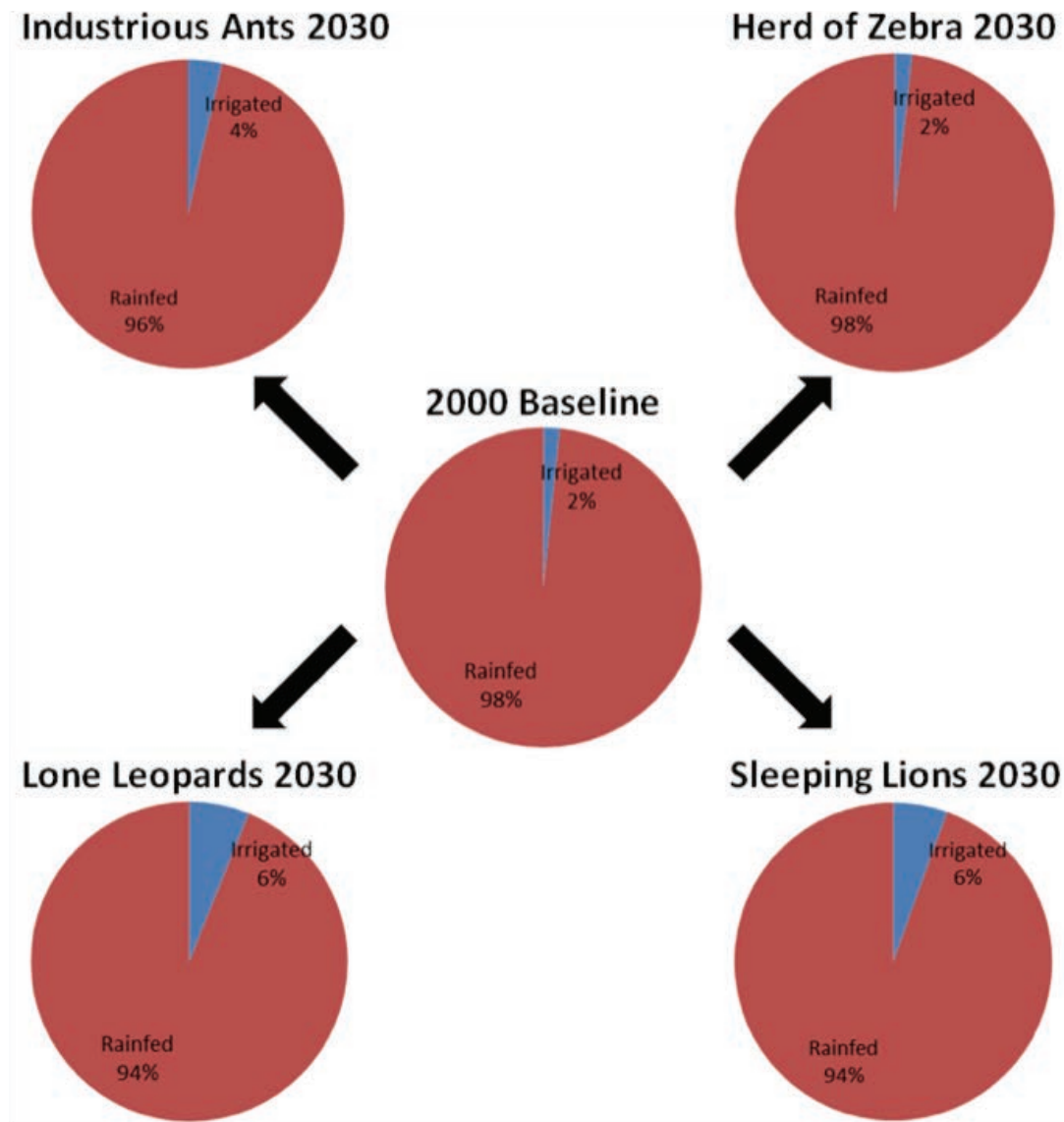


Figure 28. IMPACT Crop production systems in 2000 baseline, and for each scenario in 2030.

in the arid grassland will decrease slightly over the time period, while the mixed temperate and urban system will increase slightly over the time period. There is a broad support to raise yields for animal products. Herd of Zebra sees a similar pattern but, here, support is less effective across the board. In Lone Leopards, support for is mainly focused on yields of animal products associated with urbanization, like poultry, and farming systems associated with this production. Sleeping Lions also sees no support for yield increase and a focus on urbanization-oriented production systems.

In IMPACT, the livestock yields are driven by an exogenous yield trend that is an input into the model. For the number of animals slaughtered, there is an exogenous trend on herd size, but there is also an endogenous response to prices of the animal product and of the animal feeds. For the scenarios, the exogenous trend in livestock yields in IMPACT sees a productivity increase for beef, lamb, milk, pork and poultry in the Industrious Ants and Herd of Zebra scenarios. While the Lone Leopards scenario sees rather small productivity increases and in the Sleeping Lions scenarios, there is no improvement in livestock yield from 2010 to 2030.

The positive trend in herd size for all livestock is the Industrious Ants highlighted by the large increase in the lamb, pork, beef, milk, and poultry sectors, while in the Herd or Zebra the number of livestock should increase but not as dramatically for milk and pork. The dramatic increase in the numbers of livestock is due to the storyline for both scenarios which sees increased support for agricultural production as well as higher yields in feed crops. In the Lone Leopards scenario the increase in livestock numbers is relatively stable and increasing for all livestock sectors, but highest for beef, lamb and poultry. The numbers of livestock in Sleeping Lions is relatively small throughout the period due to the lack of support for agriculture in the scenario storyline.

Land use change emissions tax

GLOBIOM is able to simulate the effects of different land use change scenarios on emissions. The model classifies six different land cover categories: managed and unmanaged forests, short rotation tree plantation, grassland, cropland, and other natural vegetation. GLOBIOM takes into account the profitability of each land type and allows land to move from one type to another. For the Industrious Ants scenario, a USD 50 tax was applied to carbon dioxide (CO₂) emissions from all land conversions in the GLOBIOM model. Currently, the IMPACT model does not include land use types other than irrigated and rainfed cropland. For the Herd of Zebra scenario, a tax of USD 10 was applied to CO₂ emissions from all land conversions in the GLOBIOM model. For the Lone Leopards scenario, a tax was applied to CO₂ emissions from only deforestation in the GLOBIOM model – which reflects the disparity between effective policies in one domain and the absence of policies in another. For the Sleeping Lions scenario, no tax was applied to CO₂ emissions from land use change.

Model outputs

Livestock demand, production and trade

Figure 30 and Figure 41 show model outputs for regional livestock demand, trade and production. Populations and GDP increase across all scenarios, driving a rising demand in a number of agricultural products. It has been observed that with increased incomes (represented by GDP in the models) individuals adjust their diets, increasing the quality and diversity of their food expenditures. Both IMPACT and GLOBIOM assume this relationship is true in East Africa, leading to increased demand for animal proteins alongside rising GDP.

Eastern Africa contributes a relatively small amount of agriculture production to the global totals. This fact is important when considering that in the GLOBIOM and IMPACT models global trade is represented in different ways. IMPACT considers trade through a global market, whereas GLOBIOM models global trade through the integration of multiple regional markets. This different representation of global trade can result in significant differences in model outputs from a change in agricultural production. GLOBIOM's regional approach to international trade allows it to capture some of the regional effects on production and commodity prices that would occur from the proactive investments of state and non-state actors in the 4 scenarios.

For instance, in the Industrious Ants scenario, investments are made in improving yields, supporting smallholders and pastoralists, lowering production costs and increasing production. In the Herd of Zebra scenario investments are less effective, and in the Lone Leopards scenario there is a mix of highly successful and less successful investments with an overall emphasis on livestock for urban consumption such as poultry. Sleeping Lions sees little to no investments overall, with poultry as an exception.

Figure 31 shows that both models have different assumptions about trade by the region with the rest of the world. This is related to the different treatments of land use in the models, which translates into different capacities for production as well as the fact that trade is organized fundamentally differently between the models: IMPACT is organized around a global market while GLOBIOM organizes trade through multi-regional interactions.

Crop demand, production and trade

Food demand is the main contributor to total demand for cassava and maize in East Africa. Food demand in both models is a function of commodity prices and consumers' income. As such, food demand for maize (Figure 45) and cassava (Figure 42) vary by scenario and over time, based on differences in GDP and prices.

Both models show increased production due to investments in productivity. However, these increases in production lead to different price effects due to the different ways IMPACT and GLOBIOM model prices. IMPACT models global markets and world prices. In commodity markets where East Africa contributes a small share of global production, increases in regional production have small effects on global prices. GLOBIOM models regional prices, therefore, changes in regional production in these same commodity markets will lead to larger price effects than in IMPACT. This larger price effect of changes in regional productivity explains differences in regional food demand between the two models. For maize, changes in regional production in IMPACT lead to limited price effects, whereas in GLOBIOM regional production directly affects regional prices leading to increased food demand. For cassava, however, changes in regional production do affect global markets in IMPACT, which lead to similar food demand trends between the models.

Feed demand makes up a smaller but significant percentage of total demand for cassava (and a small percentage for maize) in East Africa. Feed demand is driven by livestock production and by the availability/prices of other feed types. Because of differences between the two models concerning animal feed efficiencies, the two sets of scenarios outputs are different. In the GLOBIOM results, the Sleeping Lions scenario shows far less feed demand because livestock production is much lower due to an absence of investment. In IMPACT, the basic feed demand is higher and there is also a marked peak in the Lone Leopards scenario due to investments in large-scale commercial agriculture in that scenario. For maize (Figure 46), feed demand patterns are comparable to those of cassava (Figure 42), though the magnitude of the demand is less. In the Industrious Ants, Herd of Zebra and Lone Leopards scenarios, increasing livestock production leads to increasing demand for all feeds. In Sleeping Lions, livestock production is lower and this affects demand.

Calorie availability

Commodity yields are generally higher in the Industrious Ants scenario due to the broad support for agricultural development throughout the period. As discussed previously, increased yields results in an increase regional production in both models. In GLOBIOM (Figure 58), the increase in production leads to lower regional prices as well as an increase in food demand from consumers. In GLOBIOM, calorie availability per capita is highest for the Industrious Ants scenario which, as mentioned earlier, has the most investment in agricultural development.

In IMPACT (Figure 59), the increase in production for most commodities does not have much effect on world prices as the regional share of global production is relatively small. Even though increases in regional production do not directly result in an increase in calorie

availability, the overall growth in GDP per capita results in increased food demand in IMPACT. In IMPACT, calorie availability per capita is highest for the scenario with the highest GDP growth, Herd of Zebra.

Calorie availability per capita is lowest in the Sleeping Lions scenario for both models. This is due, in part, to the low/negative agricultural productivity growth in the scenario over the time period (resulting in higher regional prices for consumers) and also the assumed low GDP growth.

The differences in calorie availability between the models can be explained in the figures below. GLOBIOM and IMPACT see a slight decrease in the total calories per capita from milk during 2010–2020, and by 2030 IMPACT sees a further decline in per capita calories from milk while GLOBIOM sees a slight increase in most scenarios. Only in Sleeping Lions do both models show a significant decline in the calories consumed from milk.

For the total calories per capita from meat sources, IMPACT shows a relatively constant consumption pattern during 2010–2020, except for the Sleeping Lions scenario where there is an 8 percent decline in meat calorie consumption. By 2030, meat calories in IMPACT rise by less than 10 percent in all scenarios and decline by nearly 11 percent in the Sleeping Lions scenario. GLOBIOM shows a slight increase during 2010–2020 for all scenarios except for Sleeping Lions and then a more significant increase in consumption of meat calories in 2020–2030.

Using the figures below, which show calorie consumption per capita, we can highlight the differences between scenarios as the combination of the effects of GDP growth and the regional changes in production and consumer prices on calorie consumption.

The total food demand for meat (beef, poultry, eggs, pork, sheep and goats) increases regionally in both models and is shown in Figure 52. However, a portion of the increase in demand comes from population growth. For this reason, it is important to look at the total demand per capita. In GLOBIOM during 2010–2030, the total demand per capita increases each period for all scenarios, except the Sleeping Lions. In GLOBIOM, the capita demand for milk stays relatively constant throughout the period with a slight decline in 2020, except for the Sleeping Lions scenario where there is a significant decline in 2010–2030. In IMPACT, per capita demand for meat is nearly constant during 2010–2020 and then increases only slightly in 2030. While GDP per capita increases in each scenario, which generally leads to an increase in the per capita demand for meat, the global food demand for meat increases at a greater pace over the time period, driving up the global price for meat in IMPACT by about 70 percent in all the scenarios. Over the same time period, the global price of milk in IMPACT increases by about 50 percent in all the scenarios, resulting in an overall regional decline in the per capita demand for milk.

Emissions

An important feature of GLOBIOM is an accounting for the GHG emissions resulting from crop and livestock production as well as the emissions resulting from changes in land use such as deforestation. In Figure 60, the main sources of emissions for each scenario are presented. For crop production, the main contribution of nitrous oxide (N₂O) emissions is through the application of fertilizers. Emissions are calculated for each crop and production system and therefore the contribution of emissions reflect the overall changes in the type of production and crops being produced. As Figure 61 shows, the N₂O and methane (CH₄) emissions in the Lone Leopards and Sleeping Lions scenarios are highest by 2030. This is explained through the underlying expansion of irrigated land that is a main driver in both of those scenarios. The

shift of crop production between various types of crops as well as the shift among production systems over time leads to levels of emissions being quite different between each scenario. Emissions of CH₄ from rice production are quite small in Eastern Africa when compared with the rest of the world, but are highest for the Lone Leopards and Sleeping Lions scenarios due to the expansion of irrigated agriculture.

In Eastern Africa, livestock production is the largest contributor to the overall emissions of GHGs. This is due to the CH₄ emissions that come from all livestock production as well as emissions specifically associated with the way in which livestock are produced. Figure 62 presents the emissions from livestock production. Although emissions are highest for the Industrious Ants and Herd of Zebra scenario, the overall production of livestock is far greater (Figures 30 and 36) than in the other scenarios. This means that the emissions per tonne of output or per calorie of protein are much lower for the Industrious Ants and Herd of Zebra scenarios than for Sleeping Lions and Lone Leopards. Land extensive systems, for example, have lower yielding animals which produce more GHG emissions per metric tonne of output when compared with more intensive livestock production systems. This means that, while the overall emissions may be greater under a certain scenario where livestock production increases, the shift of production to more land intensive livestock production systems can reduce the emissions per metric tonne of output. A more detailed look at how shifts between livestock systems and the resulting effects of GHG emissions is presented by Havlik et al. (2013a).

Other forms of emissions included in the model include the emissions of CO₂ that come from deforestation – the process by which forests are cut and converted to crop or livestock production. Figure 63 presents the emissions for deforestation which in the region far outweigh the GHG emissions from other sources of GHGs. In the Sleeping Lions scenario, CO₂ emissions resulting from deforestation in 2030 are double that of the emissions from the Industrious Ants scenario where the transition from extensive systems to more intensive livestock systems dominates. Deforestation is not the only source of emissions from changes in land use, also included is Figure 64 – the conversion of other natural lands to crop and livestock producing areas. Industrious Ants and Sleeping Lions see the highest overall CO₂ emissions where there is the most conversion of other natural land to cropland and grassland for livestock. Emissions from deforestation and emissions from other land use changes are presented in Figure 65. Emissions are highest over the time period for the Sleeping Lions scenario which sees an expansion of land for agricultural production and livestock. While the emissions in 2020 for the Industrious Ants scenario are higher than the other scenarios due to the pressure for increased agricultural production, by 2030, the emissions from land use change decline and are in line with those of the other scenarios.

Land-use change

As discussed in previous sections, land will shift to producing different goods based on the overall profitability of each land-using sector. The environmental impacts of a shift in land cover from forests to crop or livestock production have been well discussed outside this report. Presented in this section are the direct changes in each sector's land use resulting from the relative productivity in each scenario.

Deforestation is one of the most widely recognizable forms of land use change. The transition of forests to cropland, grassland or to managed forests is seen in Figure 66. While deforestation is significant for each scenario throughout the early part of the period, by 2030 Sleeping Lions sees the highest loss of forests due to expansion in cropland and livestock. Figures 67 and 68 present the additional cropland and grassland for each scenario, where the expansion in area for livestock (from forests as well as other natural land) can be seen more

clearly. The crop area expands at the expense of grassland, forests and other natural land, which is largest for the Herd of Zebra and Lone Leopards scenarios. The shift from low input to high input rainfed crop production in the Industrious Ants scenario can explain the need for a relatively small increase in crop area over the time period (Figure 69). The additional crop area over the period for Herd of Zebra is seen as an increase in high and low input rainfed area, irrigated area and high input rainfed area for Lone Leopards, and simultaneous expansion of the irrigated and low input rainfed crop area in the Sleeping Lions.

In Figure 69, the area under crop production is presented for each scenario over the time period. Also presented is the distribution of the total area to each crop production system as defined by GLOBIOM. In the Industrious Ants scenario – that maintains the smallest area under crop production but the largest area outside of subsistence agriculture – is dedicated to high input rainfed agriculture which has higher yields. For this reason, as presented earlier, this scenario enjoys increases in crop production while crop area expansion increases only slightly over the time period. In the Herd of Zebra scenario, this is not the case. While the share of area under subsistence agriculture remains relatively constant in proportion to the total area, the share of area considered low input rainfed production increases over the time period to more than 60 percent of the total area under crop production. The Lone Leopards and Sleeping Lions scenarios see an increase in the share of area dedicated to irrigated production, while still increasing the share of area in low and high input rainfed agriculture. In every scenario except Industrious Ants, the overall increase in the total area under crop production grows by more than 30 percent over the time period, while in the Industrious Ants scenario total crop area only grows by 15 percent over the period, which has significant implications for the other sectors such as forests and natural land as well as land under livestock production.

Land-use change restriction schemes and effects on other outputs

One important message in the storylines was the government's ability to protect environmental health. For the main scenarios presented in the previous sections, this was not included in the modelling quantification by IMPACT or GLOBIOM. To address this important issue, GLOBIOM produced additional scenarios, where a carbon tax on the emissions resulting from changes in land use was used to simulate a government action to protect the environment. These supplemental scenarios included a carbon tax resulting from emissions related to the change of land from forest to cropland or pasture land, or from natural land to crop or pasture land. To better capture the storyline of the Industrious Ants and Herd of Zebra scenarios, a tax on all emissions resulting from changes in land use was imposed, set at USD 50 per megatonne (Mt) of CO₂ equivalent and USD 10 per Mt of CO₂ equivalent, respectively. In the Lone Leopards scenario, only a tax on emissions resulting from deforestation was imposed, and for the Sleeping Lions scenario we applied no carbon tax on emissions resulting from the changes in land use, since governments are slow to react to the protecting the environment.

Figure 70 presents the deforestation under the emissions tax schemes. While deforestation occurs up to 2010, after the tax is imposed, the level of deforestation falls in all scenarios except Sleeping Lions, where there is no emissions tax. Land is still converted to cropland as is seen in Figure 71, and where there is only a tax on the emissions from deforestation (Lone Leopards) the conversion to cropland from other sources still occurs, but is much lower than the land conversion under the normal scenarios (Figure 67). The conversion of land from pristine forests and other natural land to grasslands also still occurs under the emissions policies scenarios (Figure 72); however, when compared with the normal scenarios (Figure 68), the additional grassland is significantly less. Interestingly, the Herd of Zebra scenario sees the most reduction in land converted to grassland when compared with the normal scenarios.

Protection of the environment at the expense of food security would be an undesirable outcome, but Figures 73–76 show that there is no significant decline in calories available under the land-use change (LUC) restrictions.

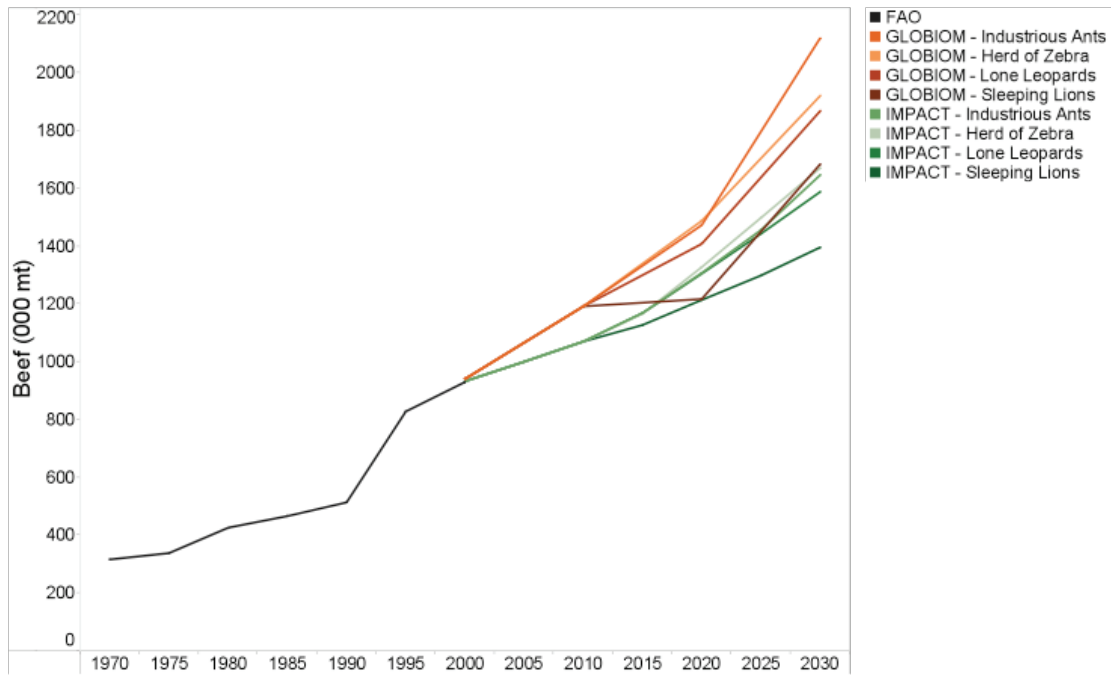


Figure 29. Regional demand for beef across the 4 scenarios from 2010 to 2030 as simulated by GLOBIOM and IMPACT.

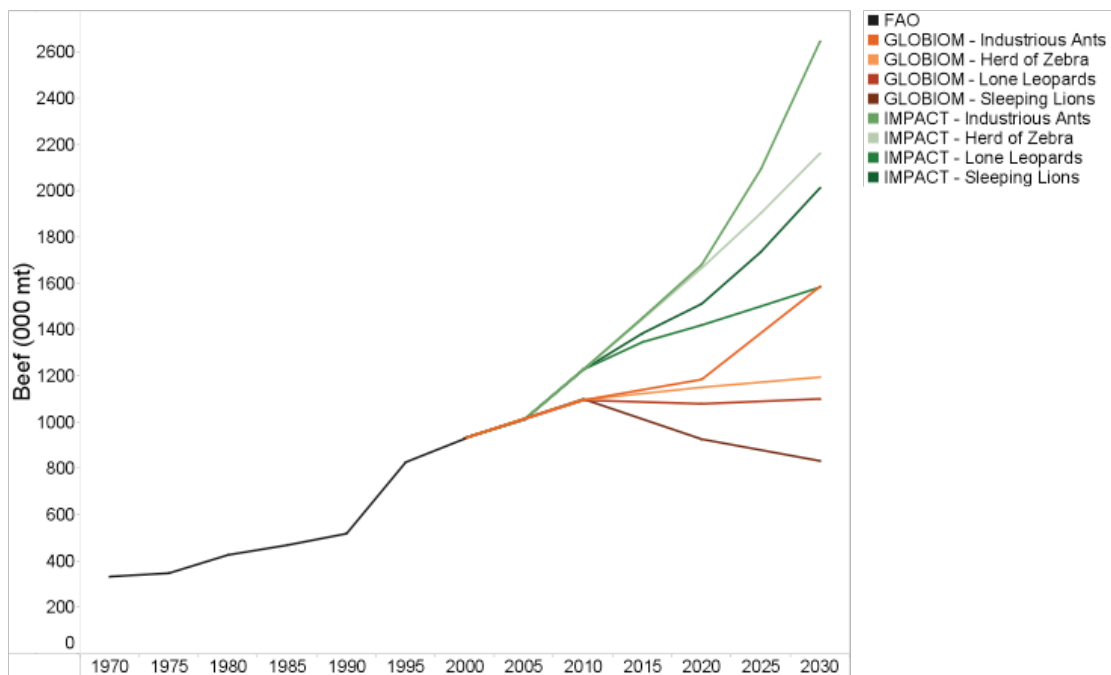


Figure 30. Regional beef production across the 4 scenarios from 2010 to 2030 as simulated by GLOBIOM and IMPACT.

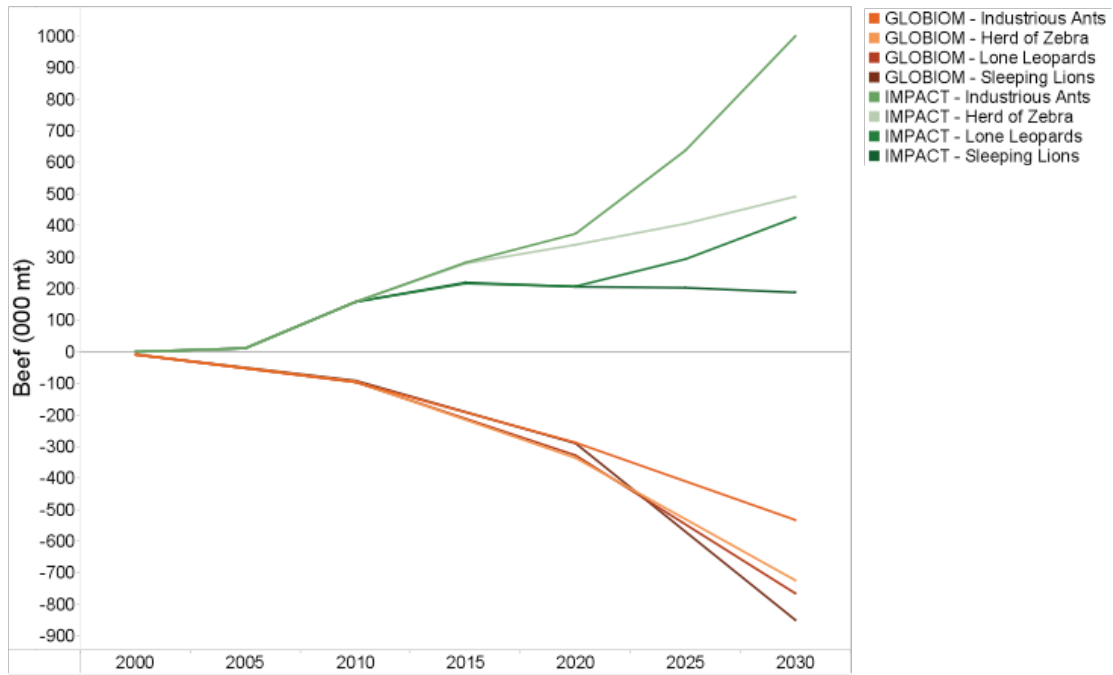


Figure 31. Net trade for beef across the 4 scenarios from 2010 to 2030 as simulated by GLOBIOM and IMPACT.

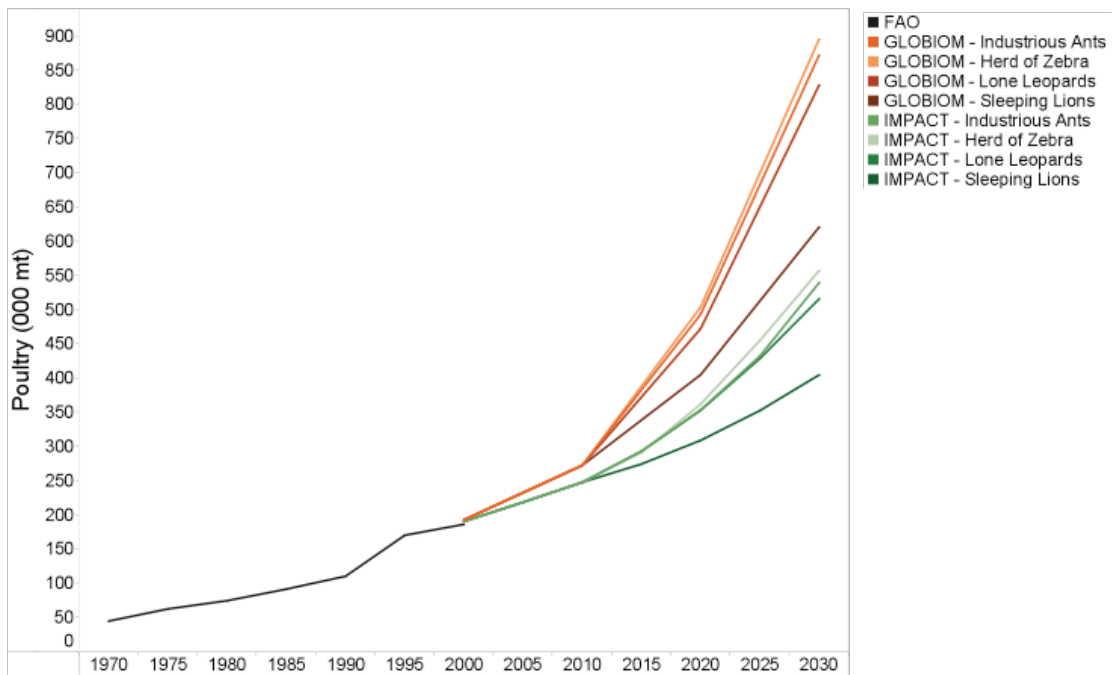


Figure 32. Regional demand for poultry, simulated across 4 scenarios for 2010, 2020 and 2030 with IMPACT and GLOBIOM.

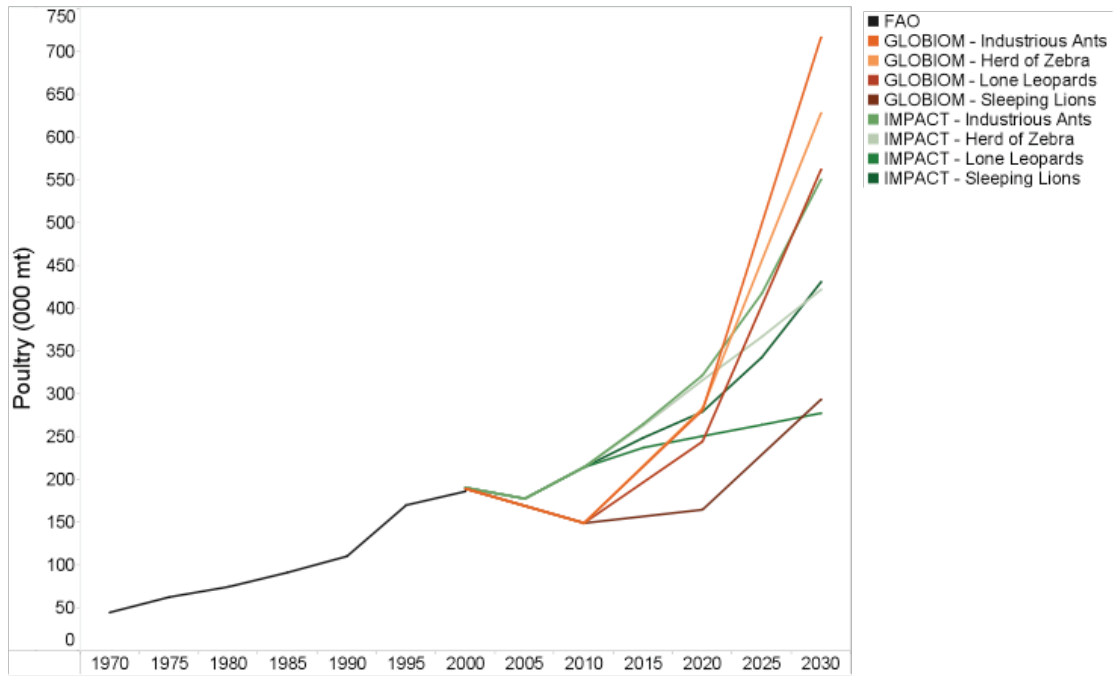


Figure 33. Regional poultry production across the 4 scenarios from 2010 to 2030 as simulated by GLOBIOM and IMPACT.

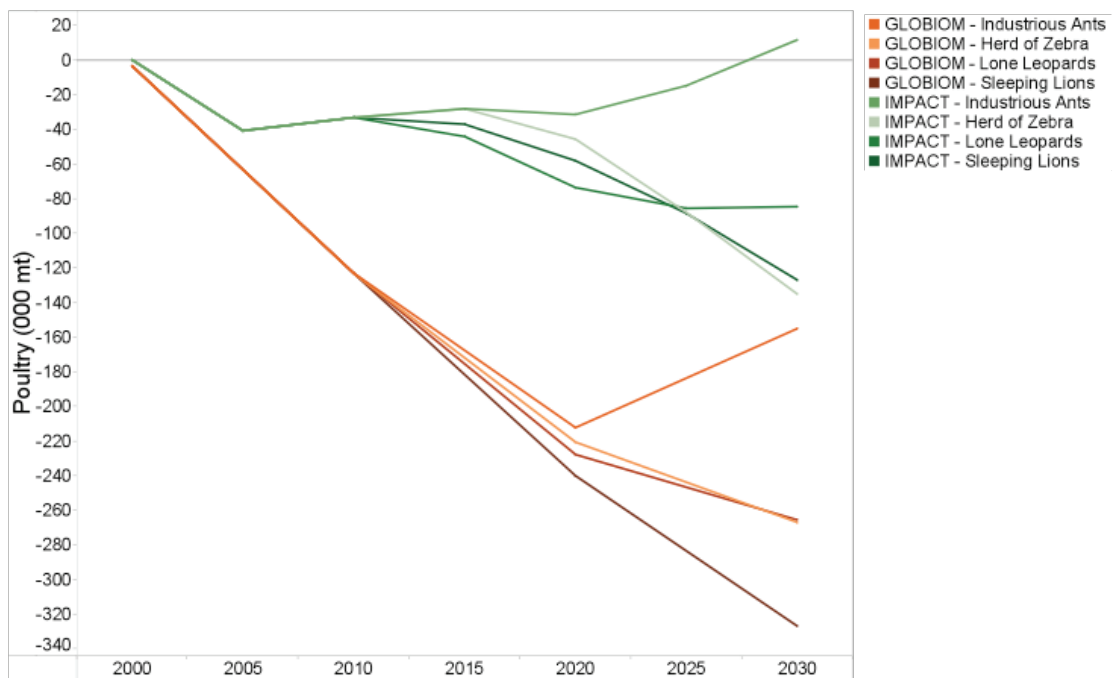


Figure 34. Regional trade in poultry across the 4 scenarios from 2010 to 2030 as simulated by GLOBIOM and IMPACT.

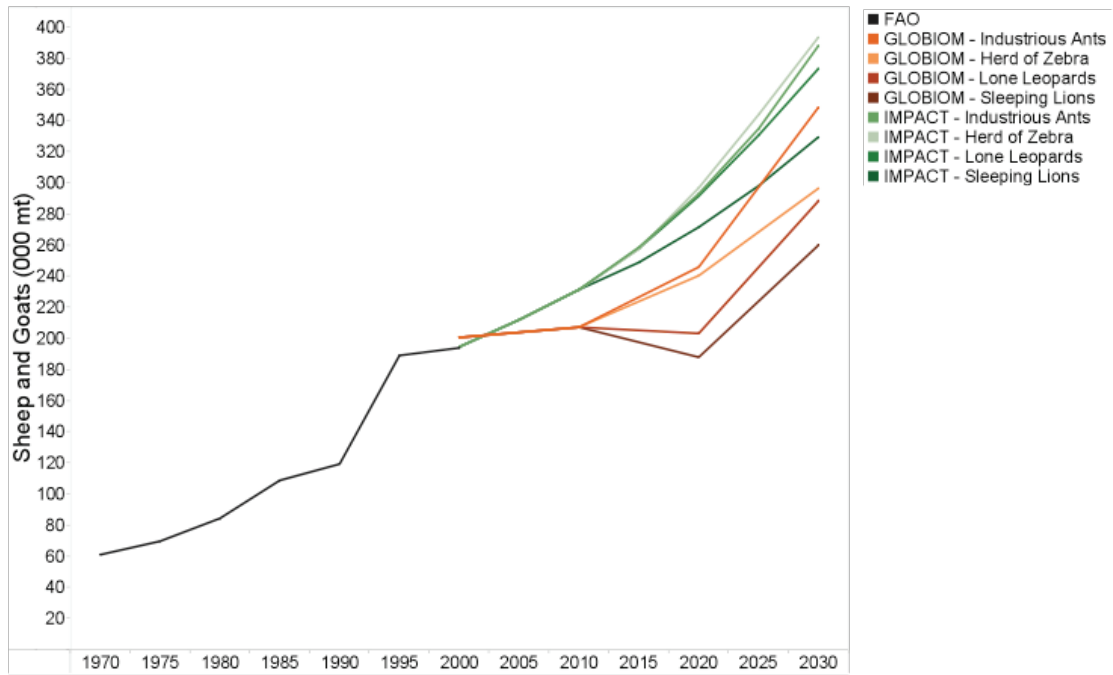


Figure 35. Regional demand for sheep and goat meat, simulated across 4 scenarios for 2010, 2020 and 2030 with IMPACT and GLOBIOM.

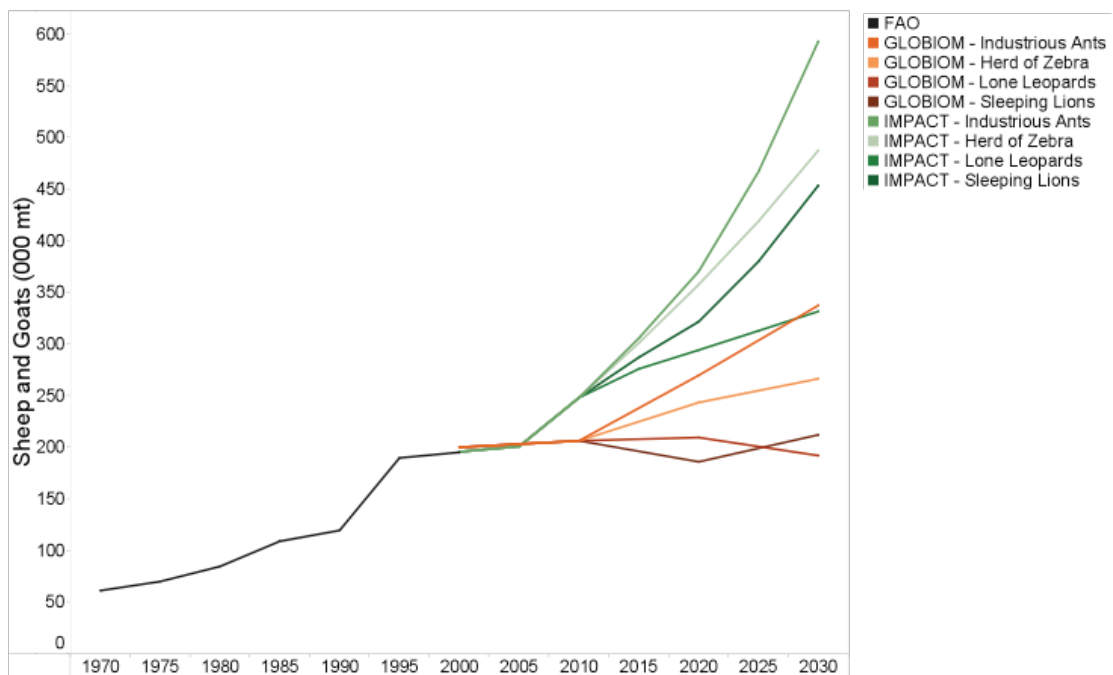


Figure 36. Regional production of sheep and goat meat, simulated across 4 scenarios for 2010, 2020 and 2030 with IMPACT and GLOBIOM.

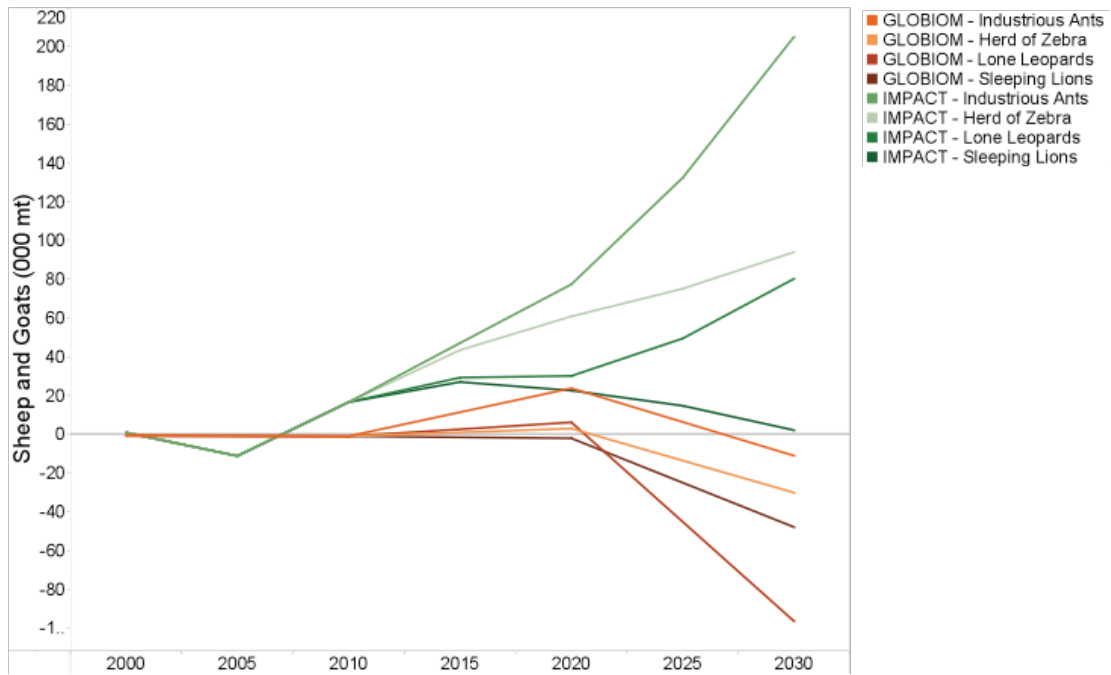


Figure 37. Regional trade of sheep and goat meat, simulated across 4 scenarios for 2010, 2020 and 2030 with IMPACT and GLOBIOM.

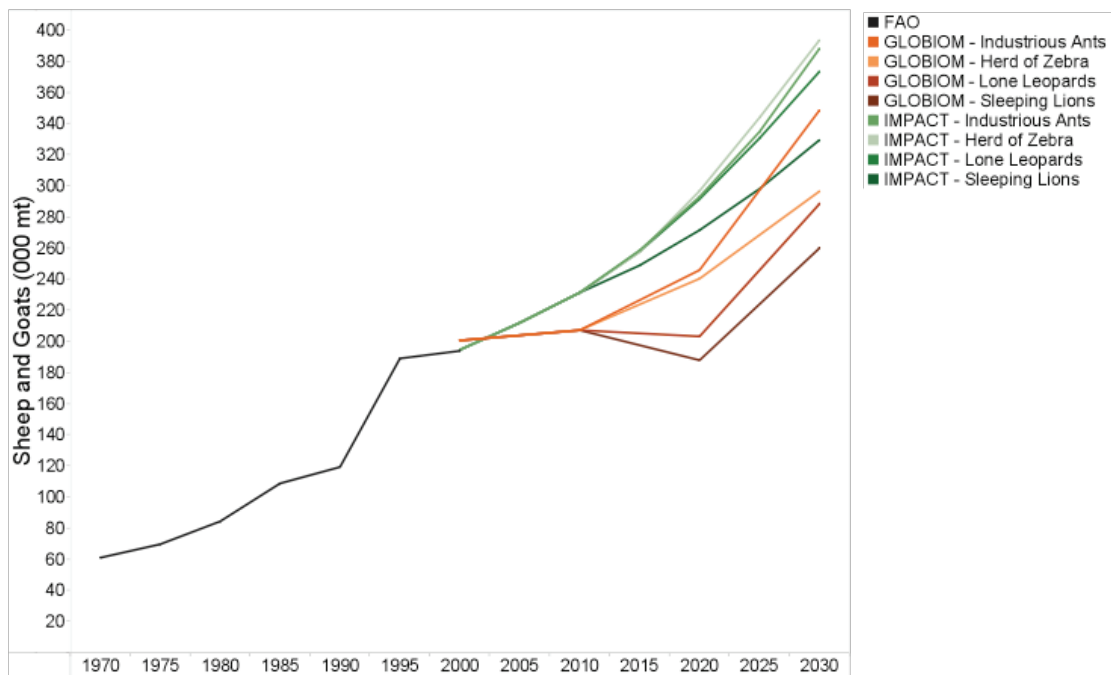


Figure 38. Regional milk demand across 4 scenarios for 2010, 2020 and 2030 as simulated by GLOBIOM and IMPACT.

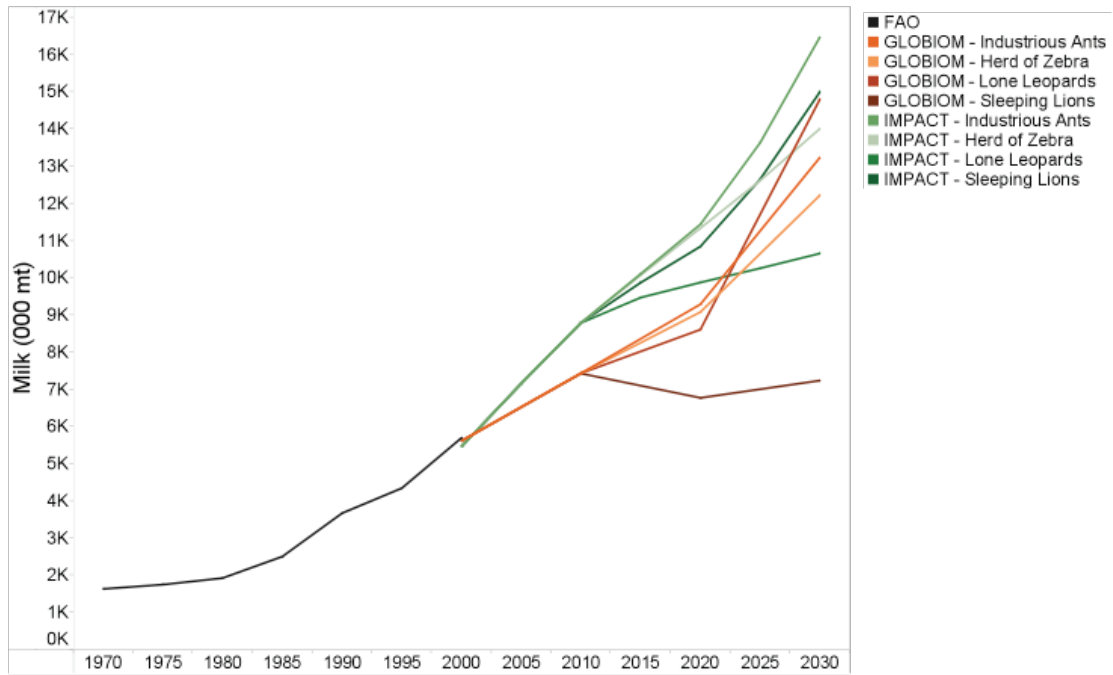


Figure 39. Regional milk production across 4 scenarios for 2010, 2020 and 2030 as simulated by GLOBIOM and IMPACT.

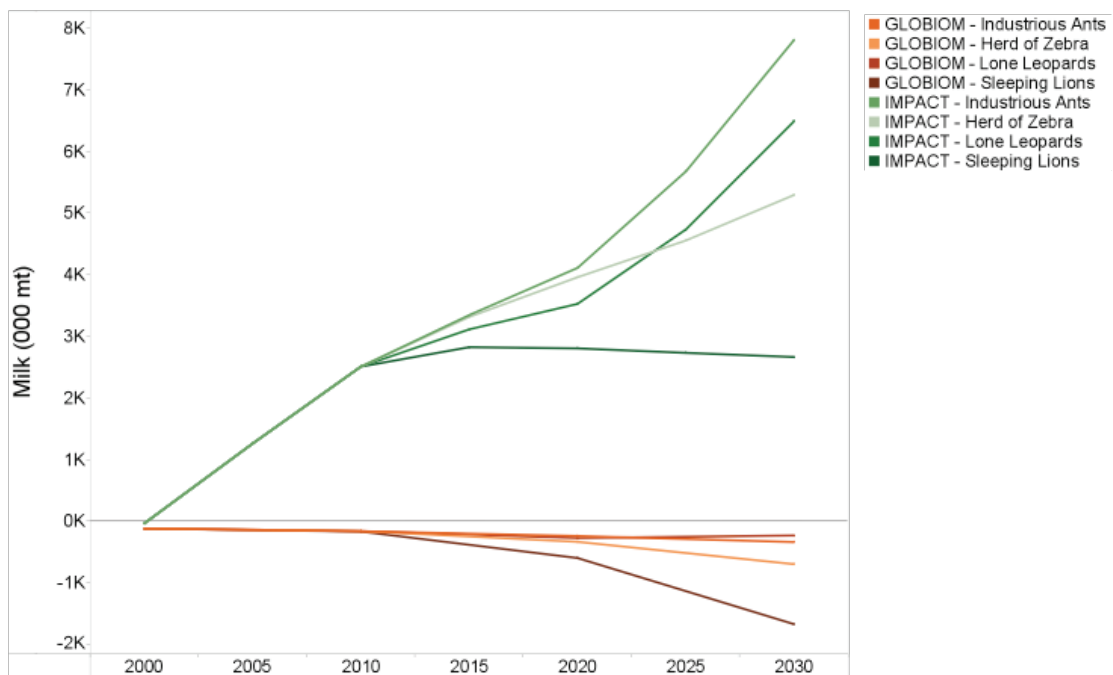


Figure 40. Regional milk trade across 4 scenarios for 2010, 2020 and 2030 as simulated by GLOBIOM and IMPACT.

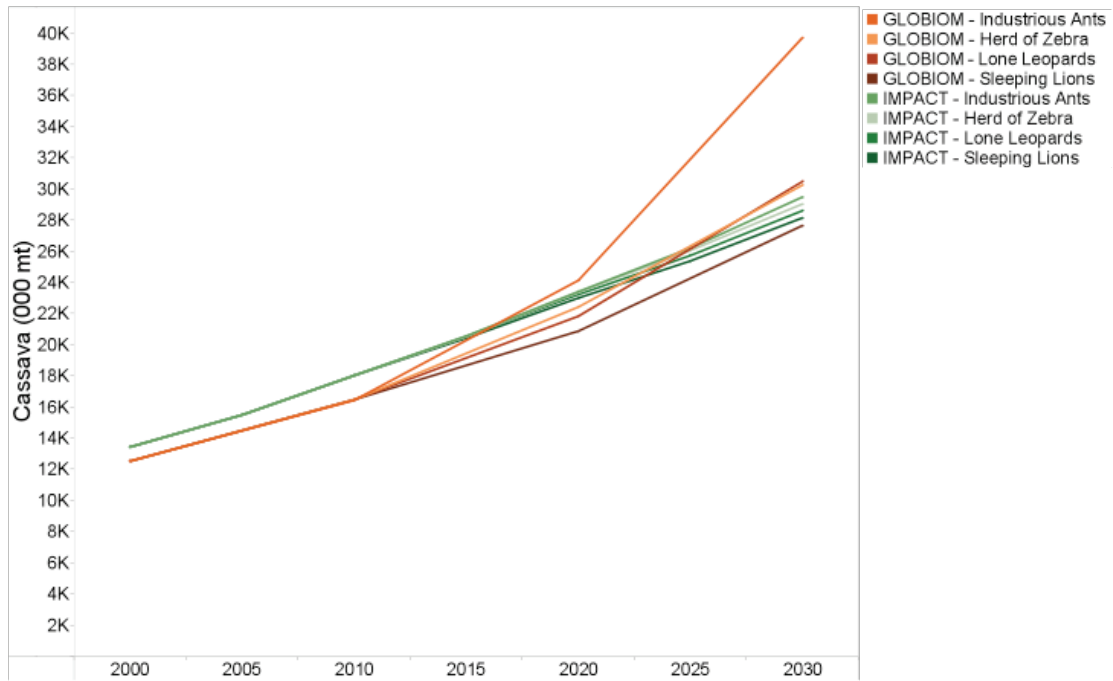


Figure 41. Food demand across 4 scenarios for cassava in 2010, 2020 and 2030 as simulated by GLOBIOM and IMPACT.

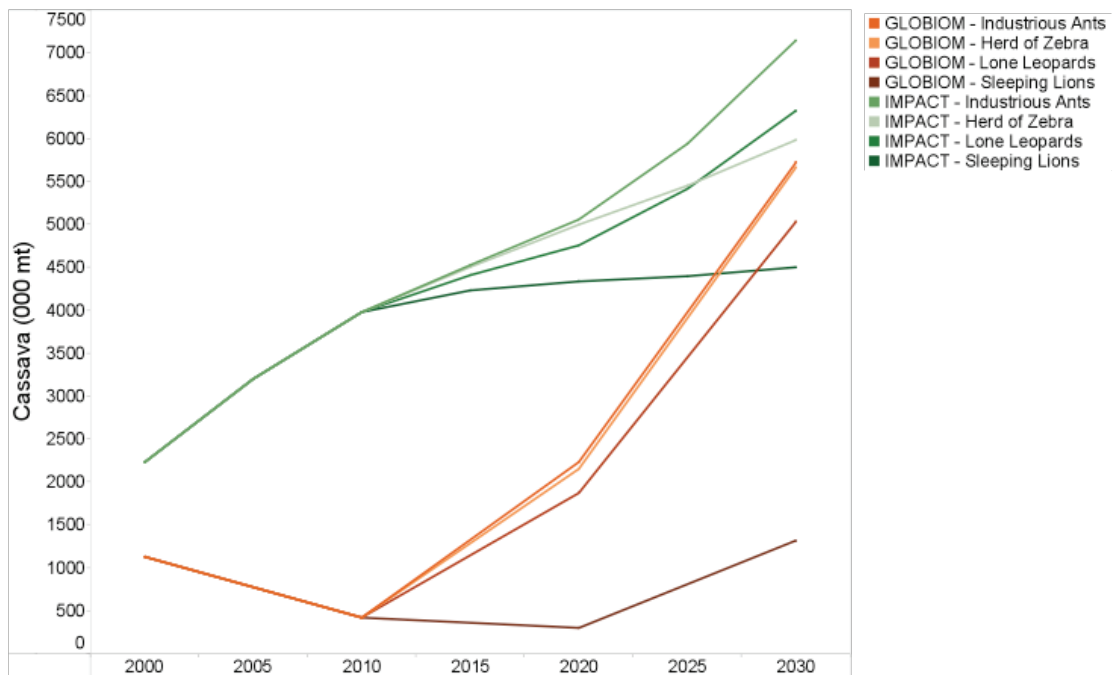


Figure 42. Feed demand across 4 scenarios for cassava 2010, 2020 and 2030 as simulated by GLOBIOM and IMPACT.

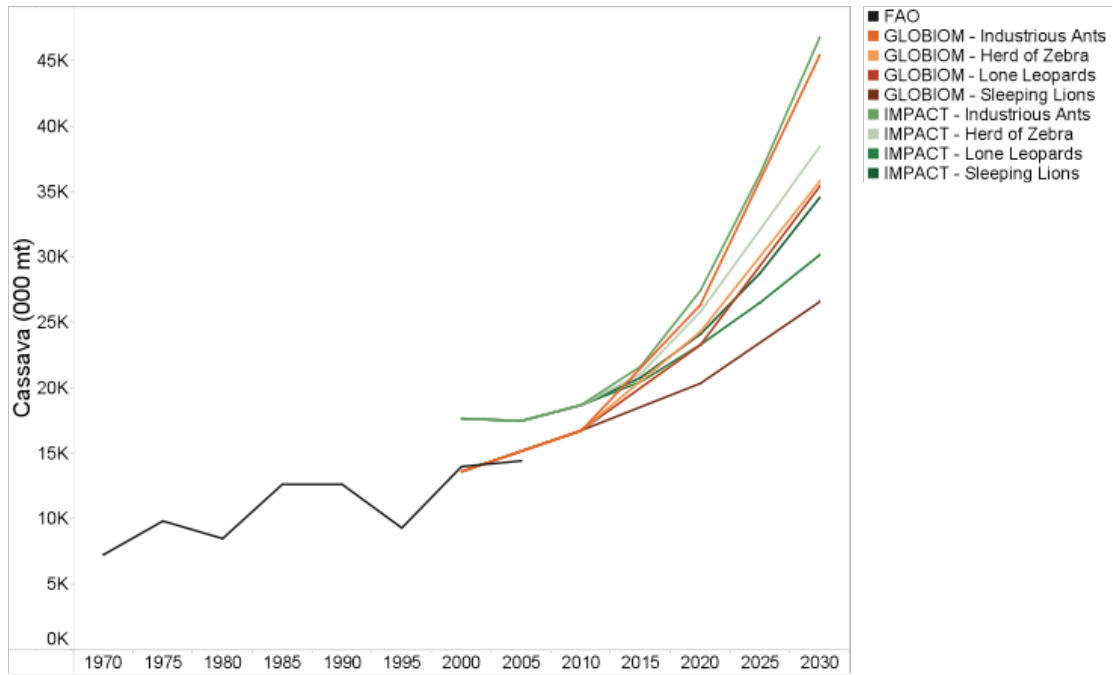


Figure 43. Production across 4 scenarios for cassava 2010, 2020 and 2030 as simulated by GLOBIOM and IMPACT.

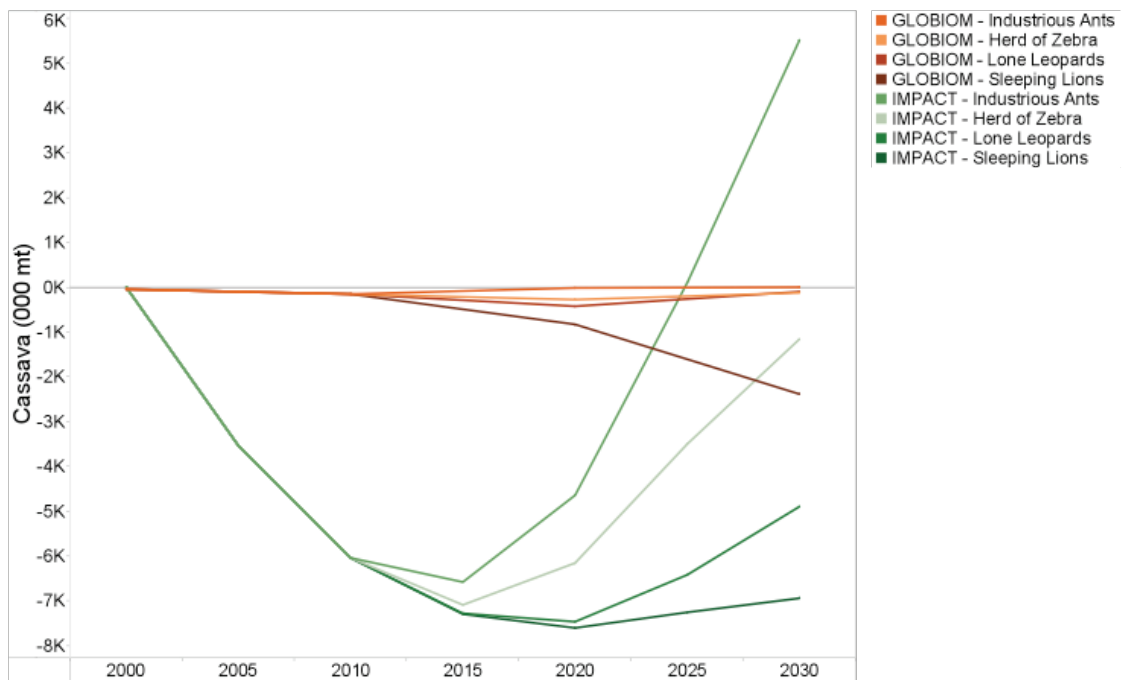


Figure 44. Net trade for East Africa across 4 scenarios for cassava 2010, 2020 and 2030 as simulated by GLOBIOM and IMPACT.

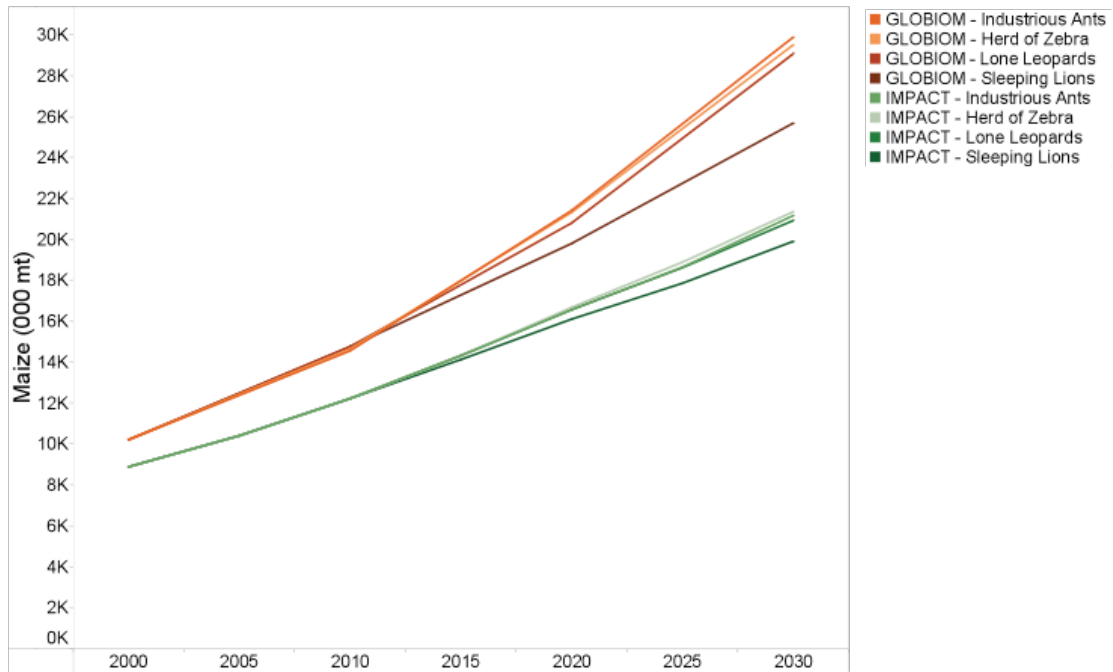


Figure 45. Food demand across 4 scenarios for maize in 2010, 2020 and 2030 as simulated by GLOBIOM and IMPACT.

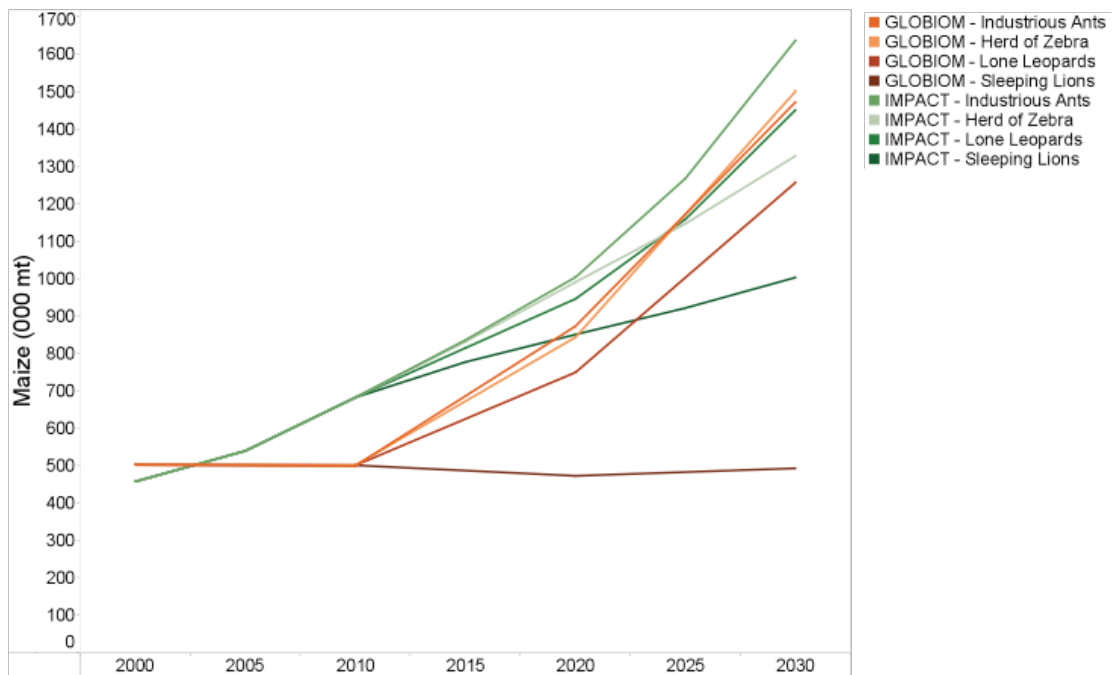


Figure 46. Feed demand across 4 scenarios for maize in 2010, 2020 and 2030 as simulated by GLOBIOM and IMPACT.

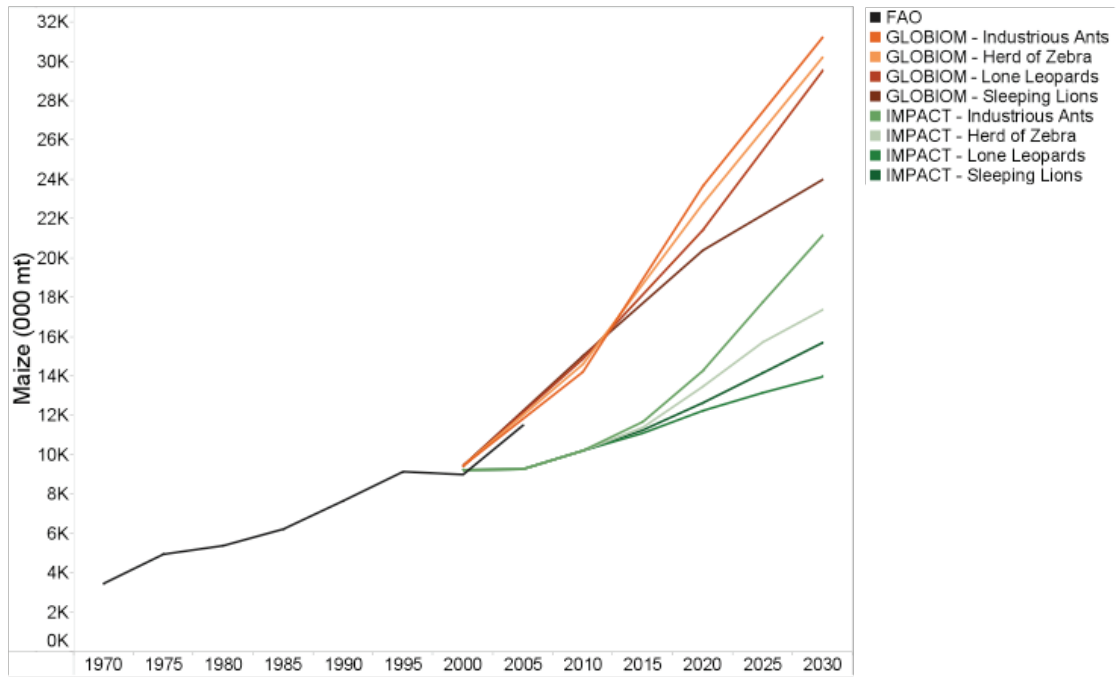


Figure 47. Production across 4 scenarios for maize in 2010, 2020 and 2030 as simulated by GLOBIOM and IMPACT.

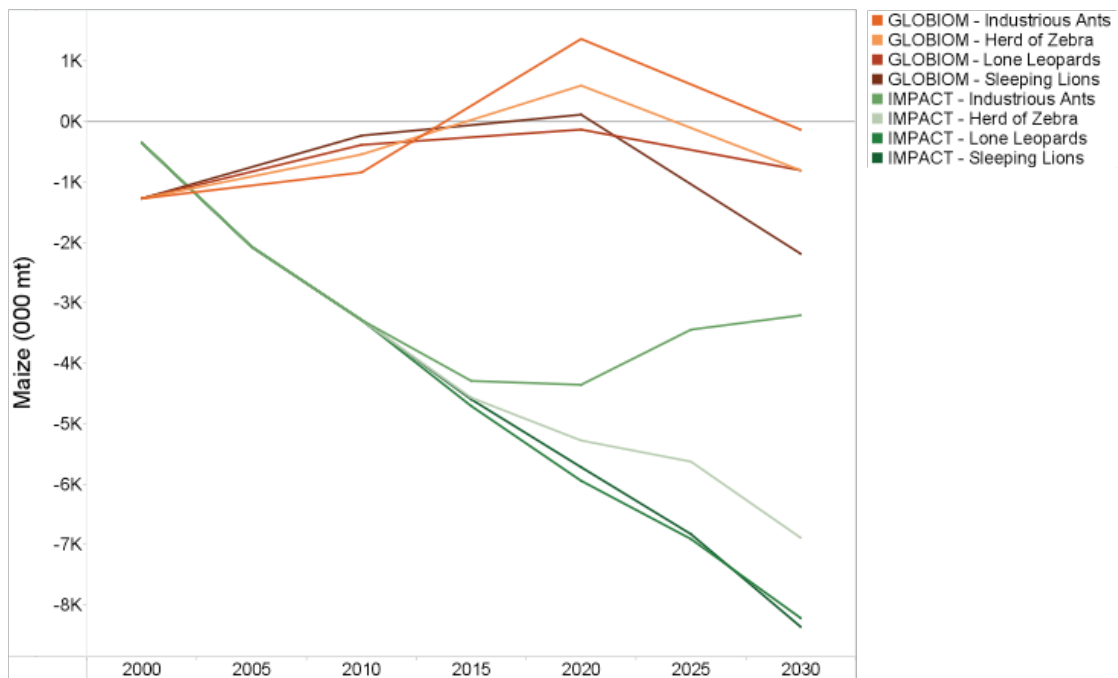


Figure 48. Regional net trade across 4 scenarios for maize in 2010, 2020 and 2030 as simulated by GLOBIOM and IMPACT.

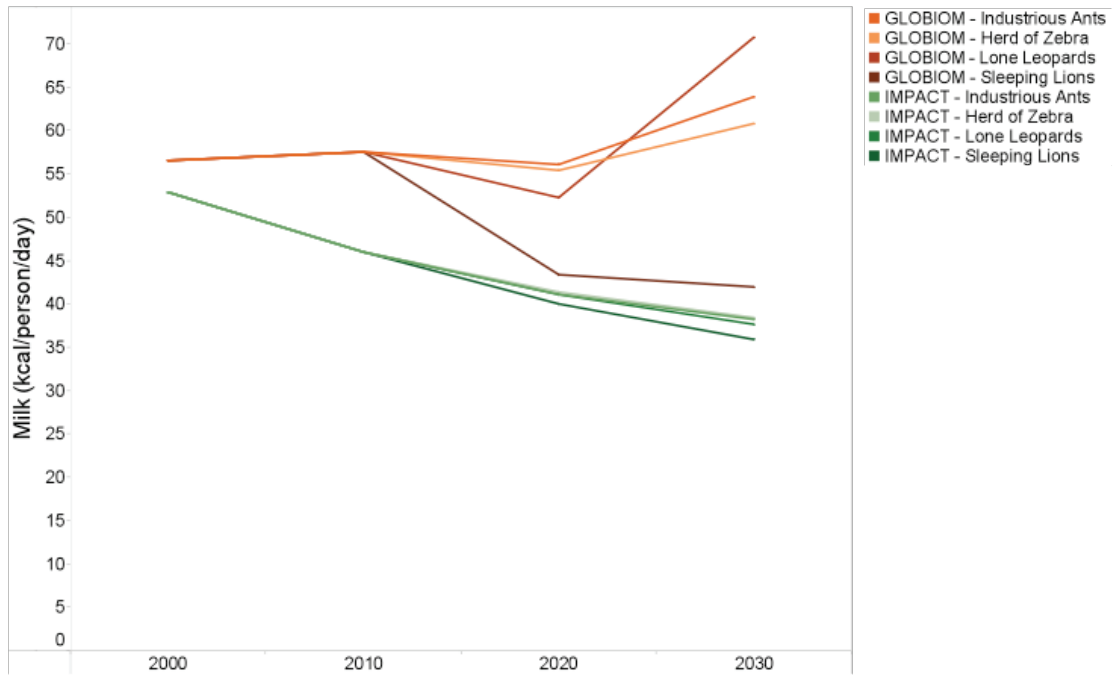


Figure 49. Total calorie consumption per capita (from milk).

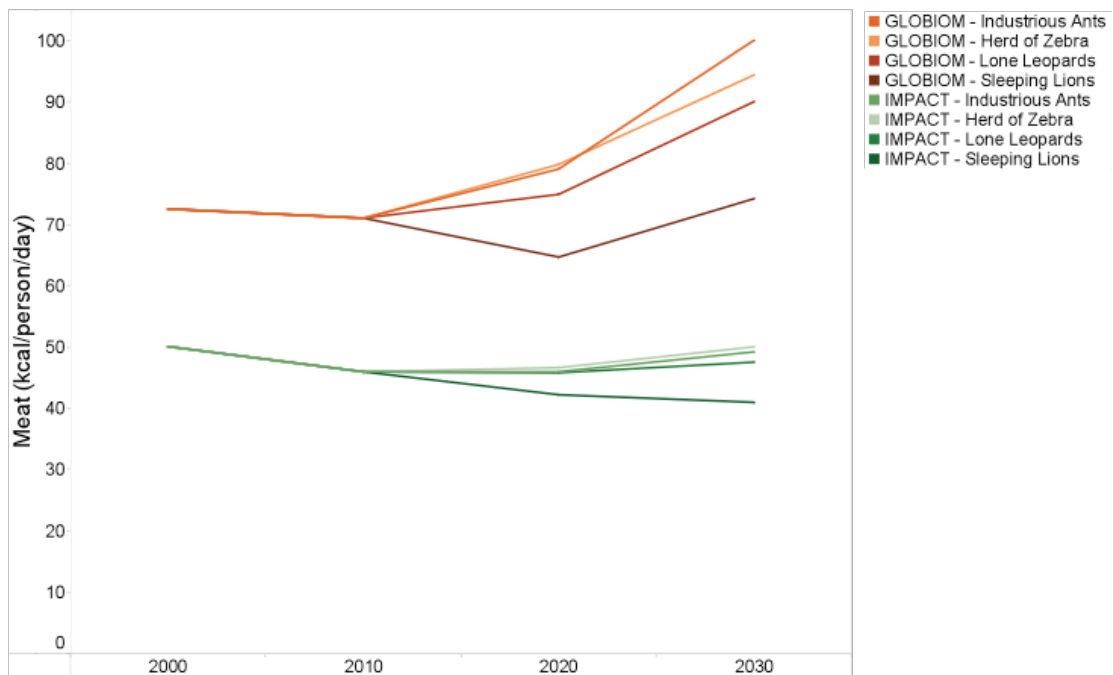


Figure 50. Total calories per capita (from meat) beef, poultry, eggs, pork, sheep and goats.

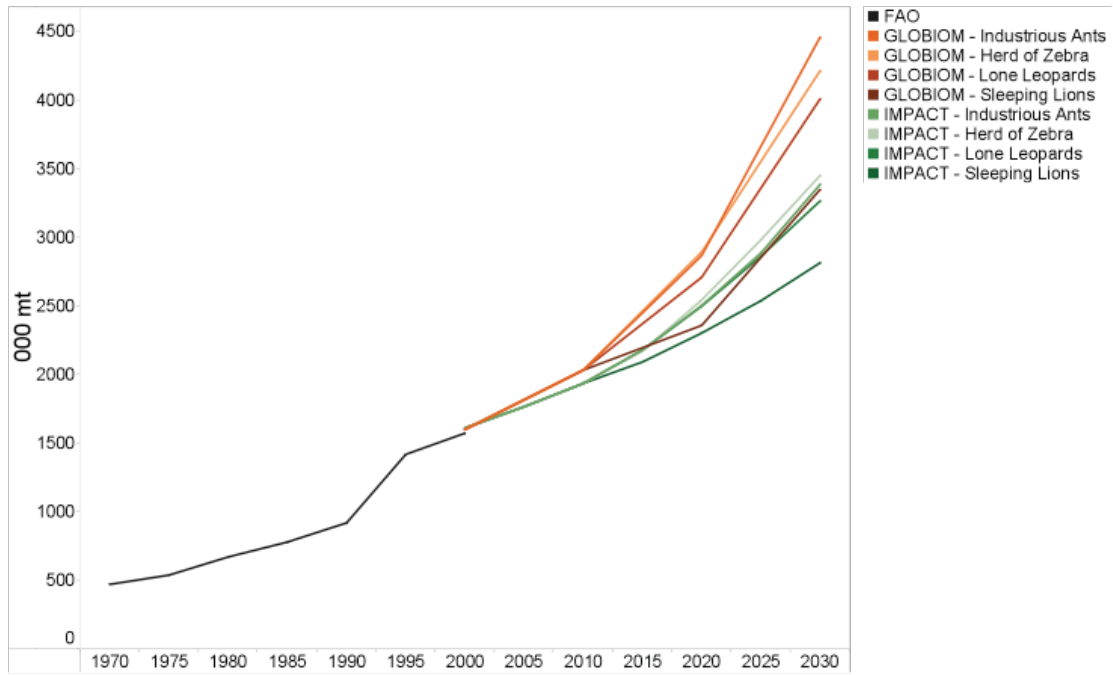


Figure 51. Total demand for beef, eggs, pork, poultry, sheep and goats.



Figure 52. Total food demand per capita for beef, eggs, pork, poultry, sheep and goats.

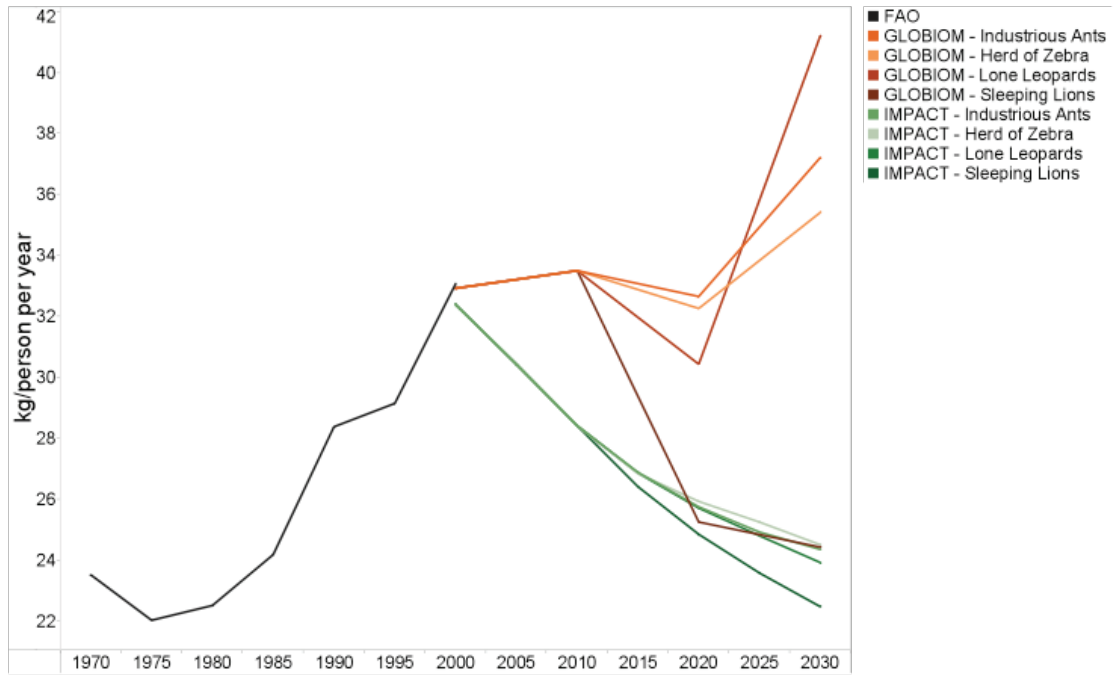


Figure 53. Total demand per capita for milk.

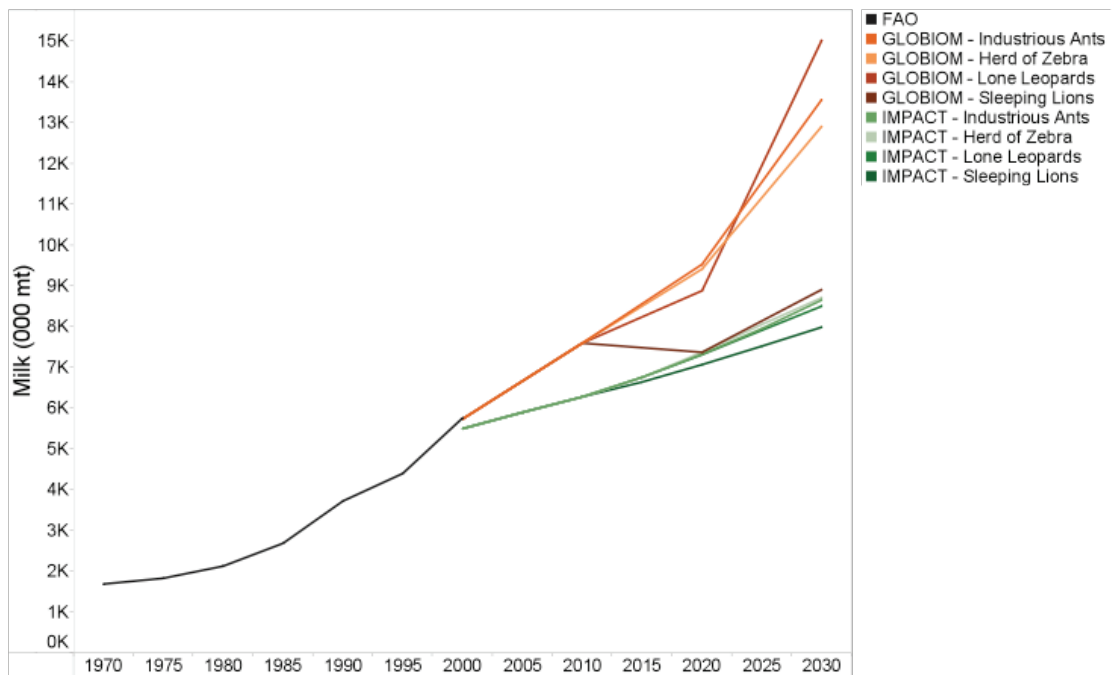


Figure 54. Total demand for milk.

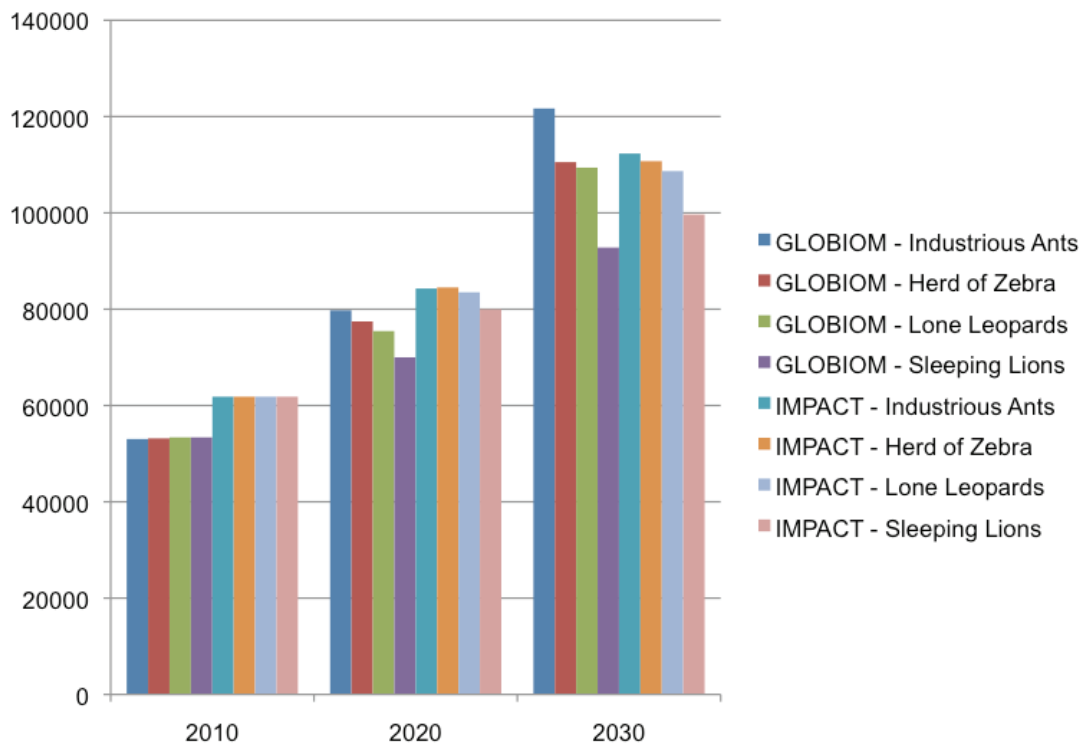


Figure 55. Total food demand for crop and livestock products.

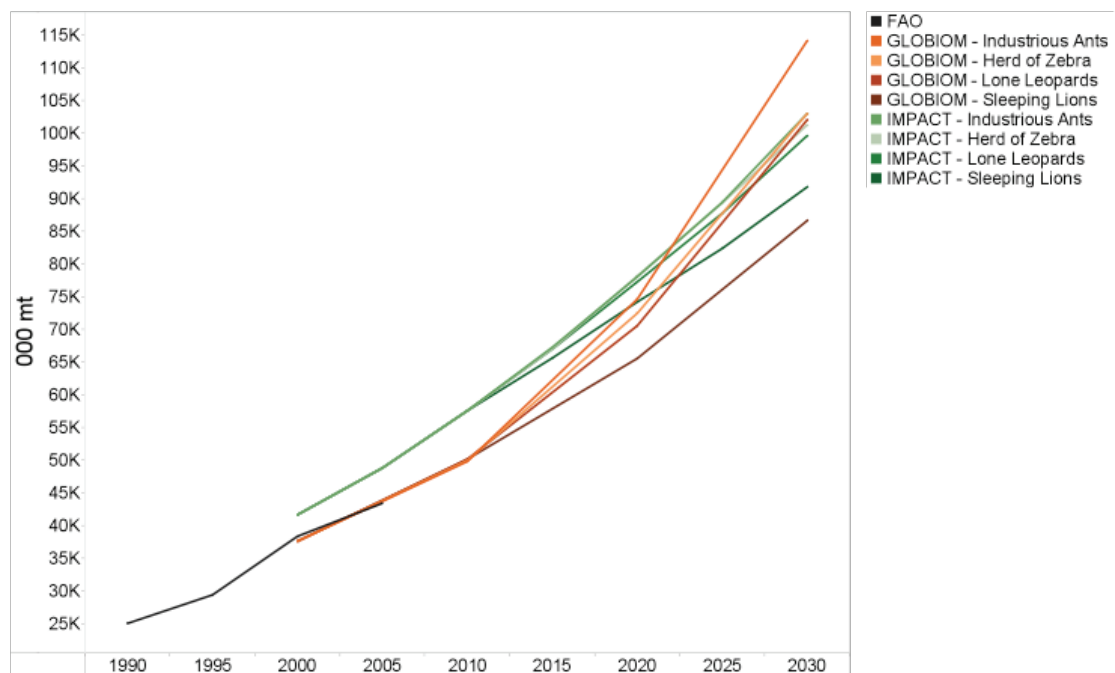


Figure 56. Total demand for main food staples cassava, wheat, maize, sorghum, millet, sweet potatoes, and potatoes.

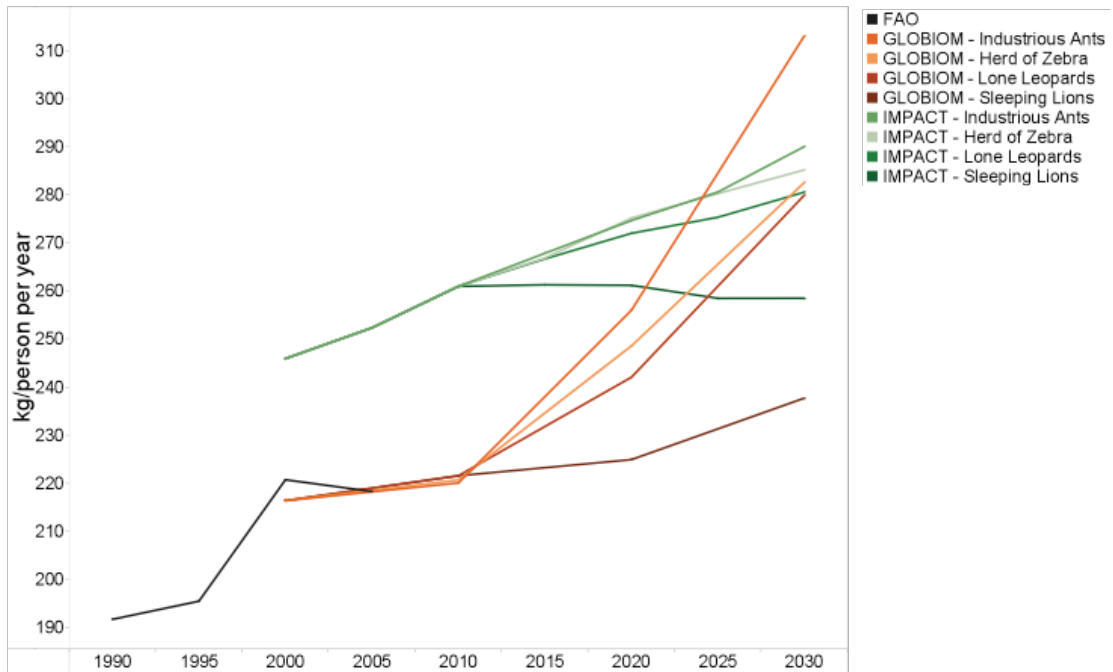


Figure 57. Total demand per capita for main food staples cassava, wheat, maize, sorghum, millet, sweet potatoes, and potatoes.

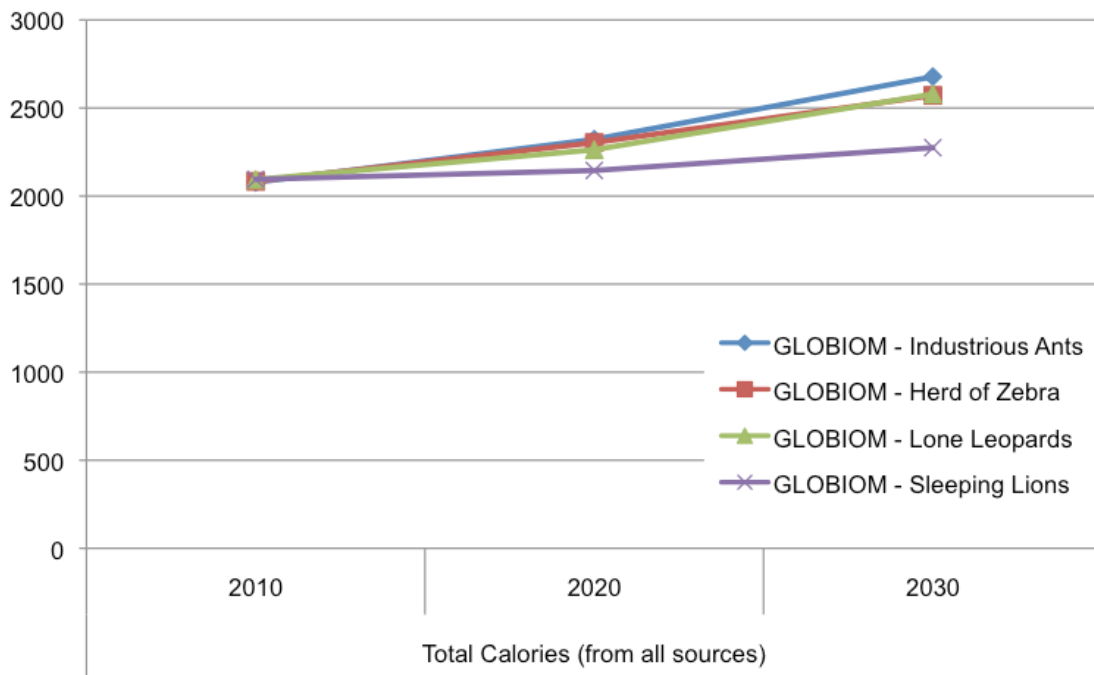


Figure 58. Total calorie availability per capita per day from all sources up to 2030 – from GLOBIOM results.

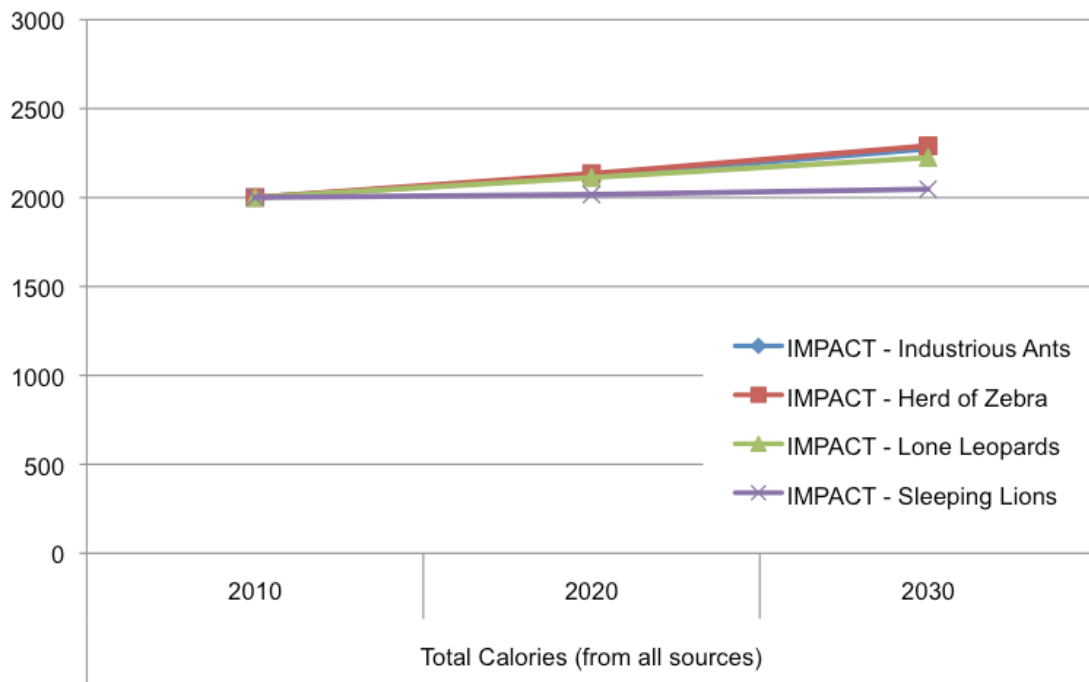


Figure 59. Total calorie availability per capita per day from all sources up to 2030 from IMPACT results.

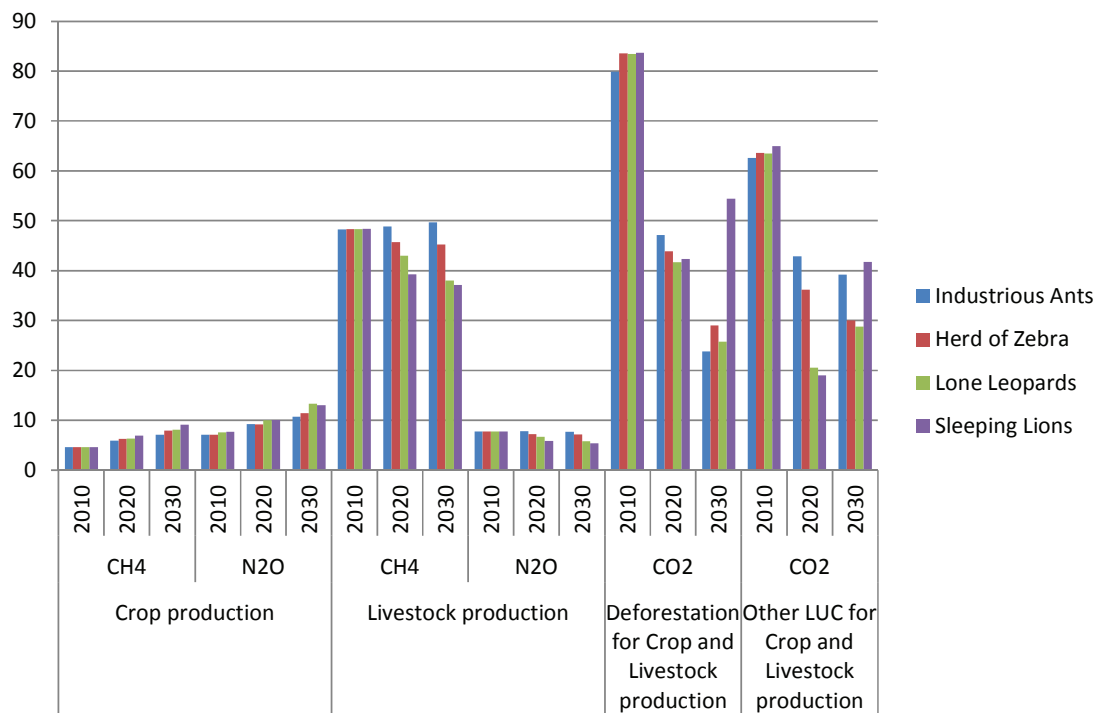


Figure 60. Emissions (Mt per year) from GLOBIOM.

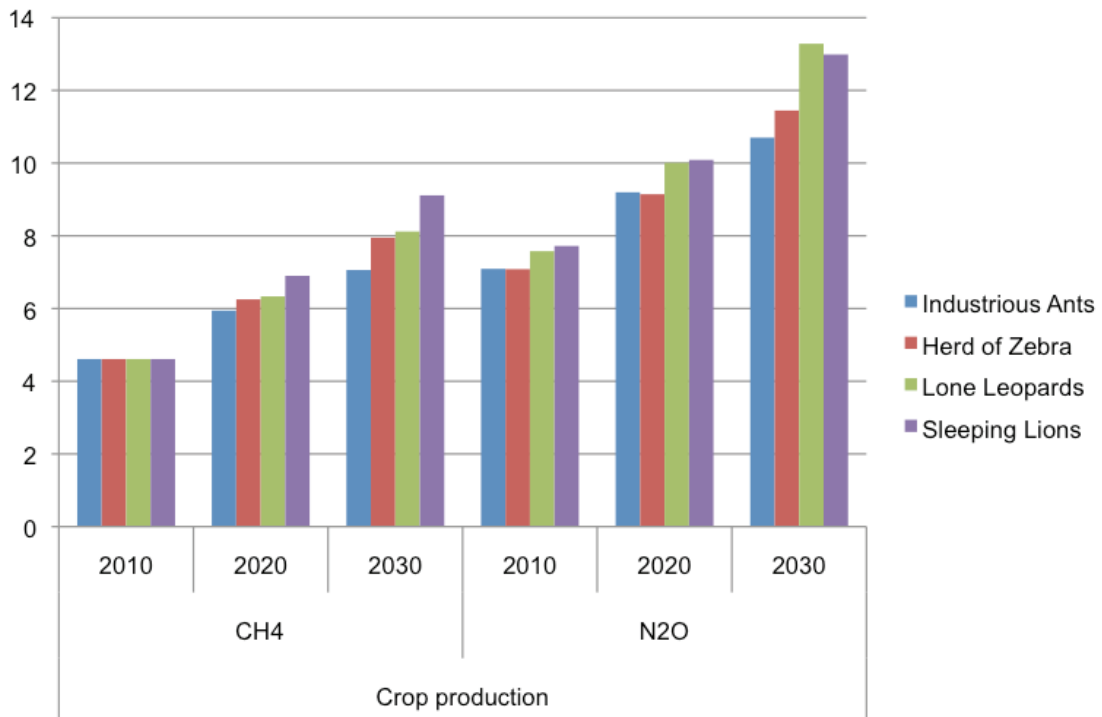


Figure 61. Emissions of CH₄ and N₂O from crop production only (Mt CO₂ equivalent per year) from GLOBIOM.

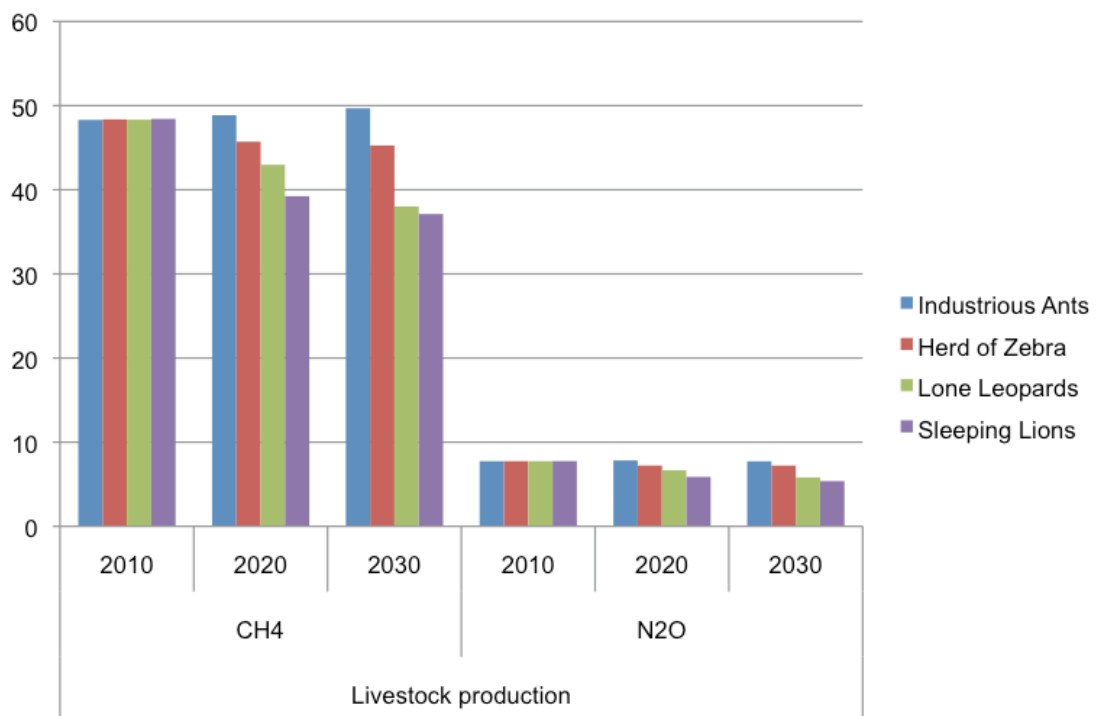


Figure 62. Emissions from livestock production (Mt per year) from GLOBIOM.

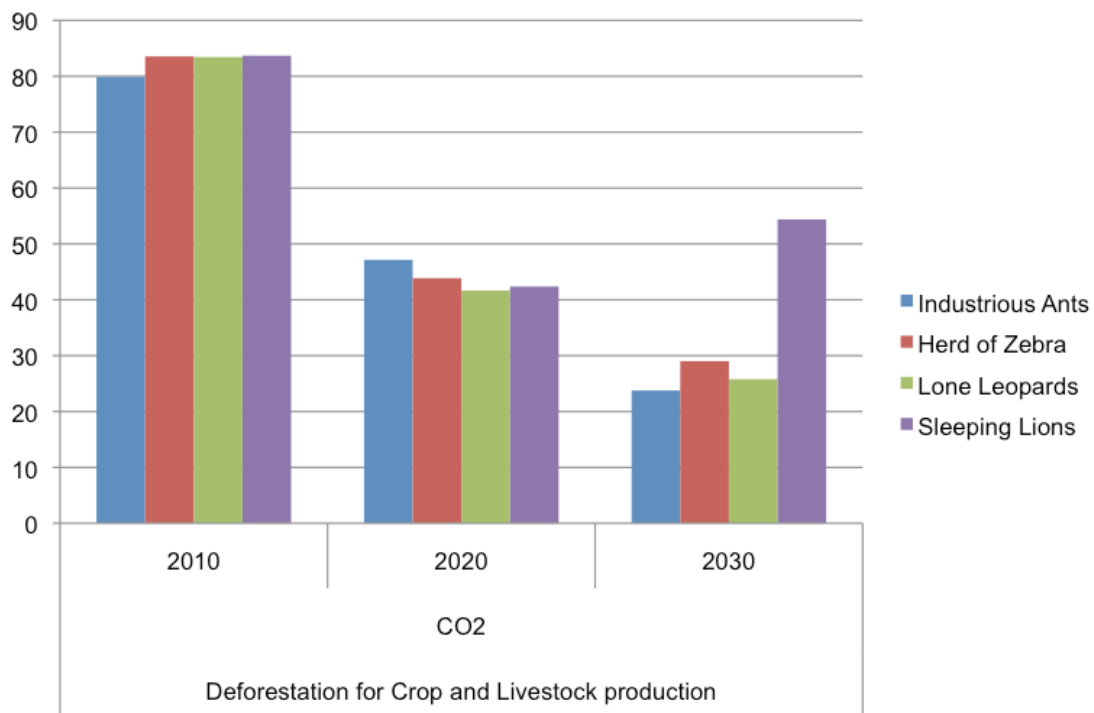


Figure 63. Emissions from deforestation (conversion of forest land to crop and livestock) (Mt CO₂ per year) from GLOBIOM.

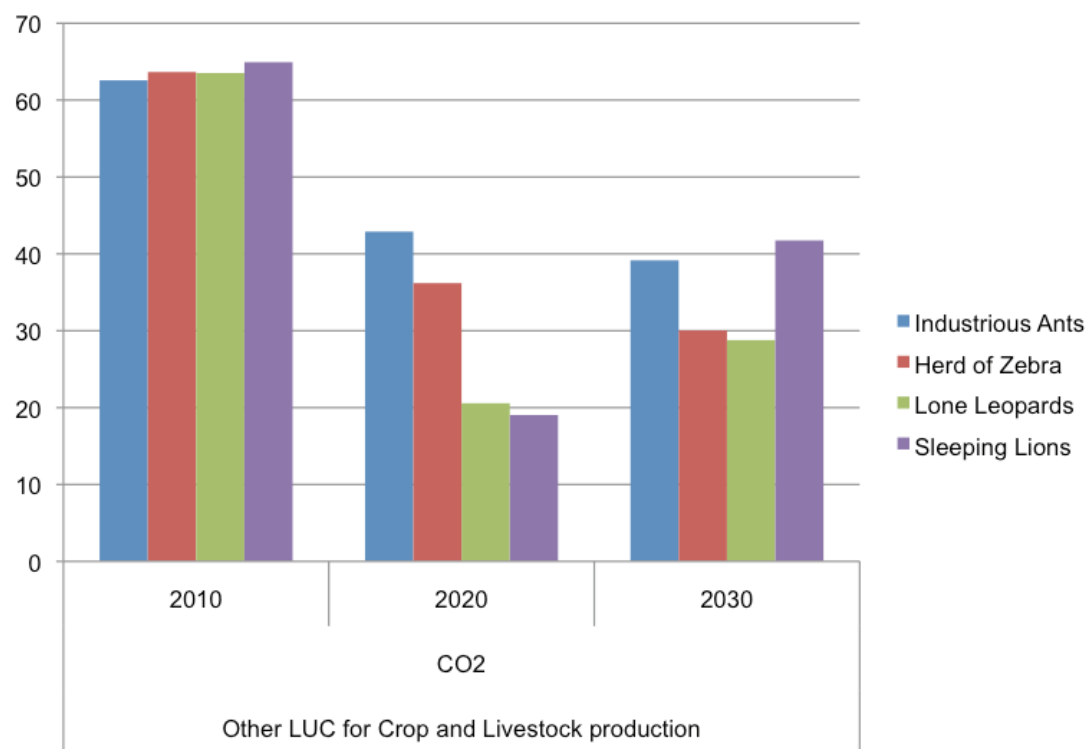


Figure 64. CO₂ emissions from conversion of other natural land to crop and livestock production (Mt CO₂ per year) from GLOBIOM.

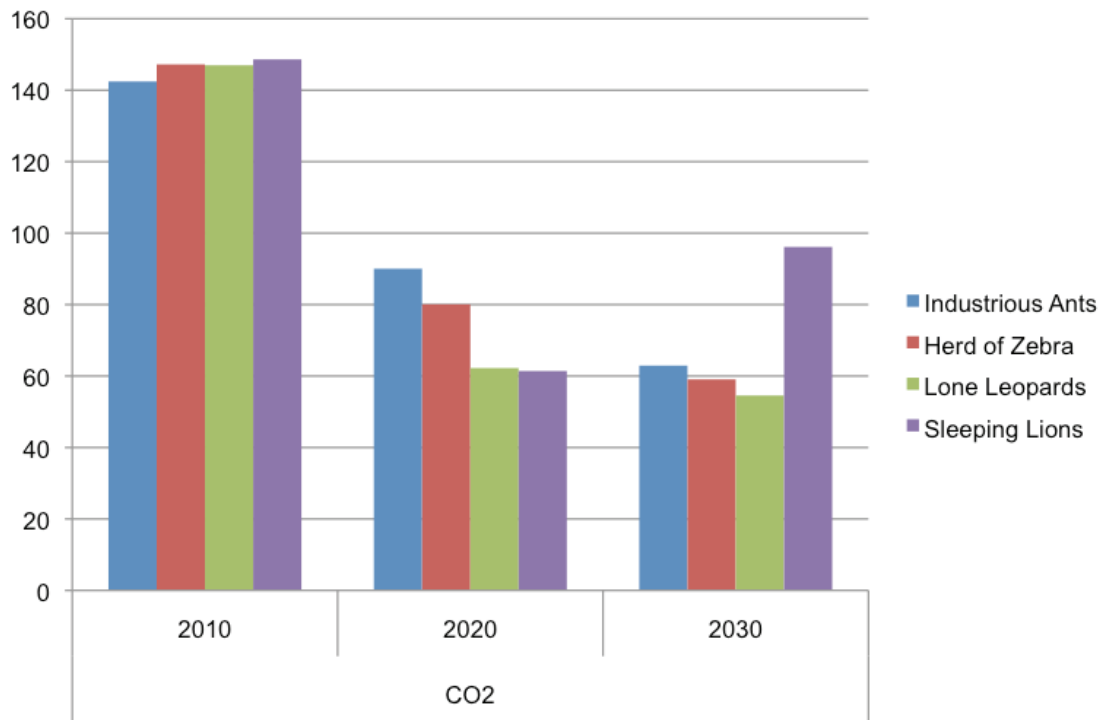


Figure 65. Emissions from all land use change including deforestation (Mt CO₂ per year) from GLOBIOM.

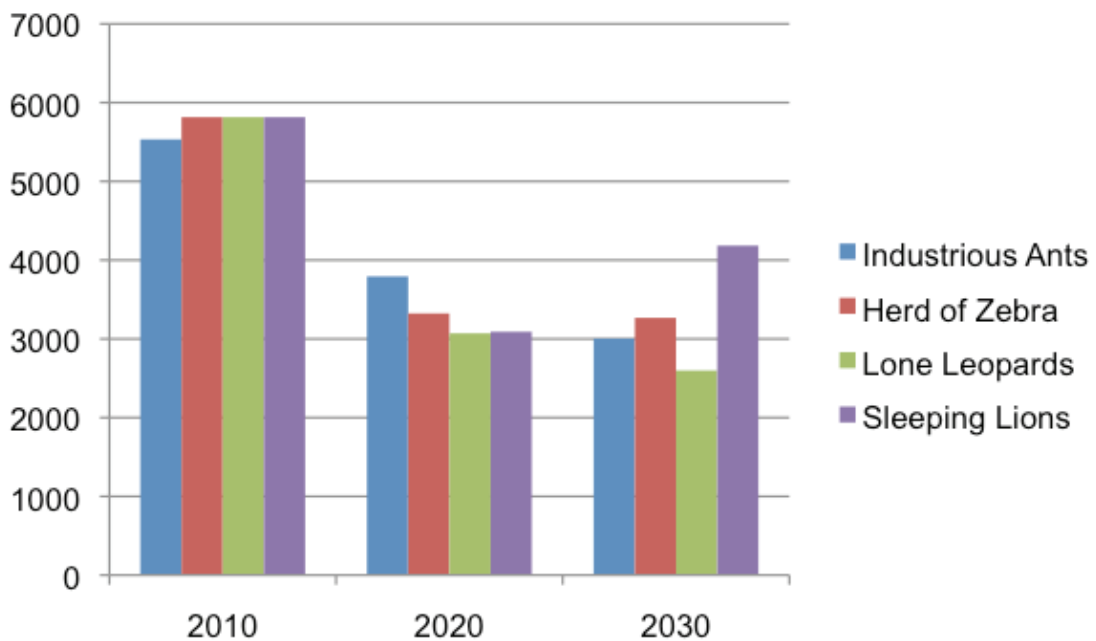


Figure 66. Total deforestation per 1000 ha (conversion of forest land to crop, livestock or from pristine forests to managed forests) from GLOBIOM.

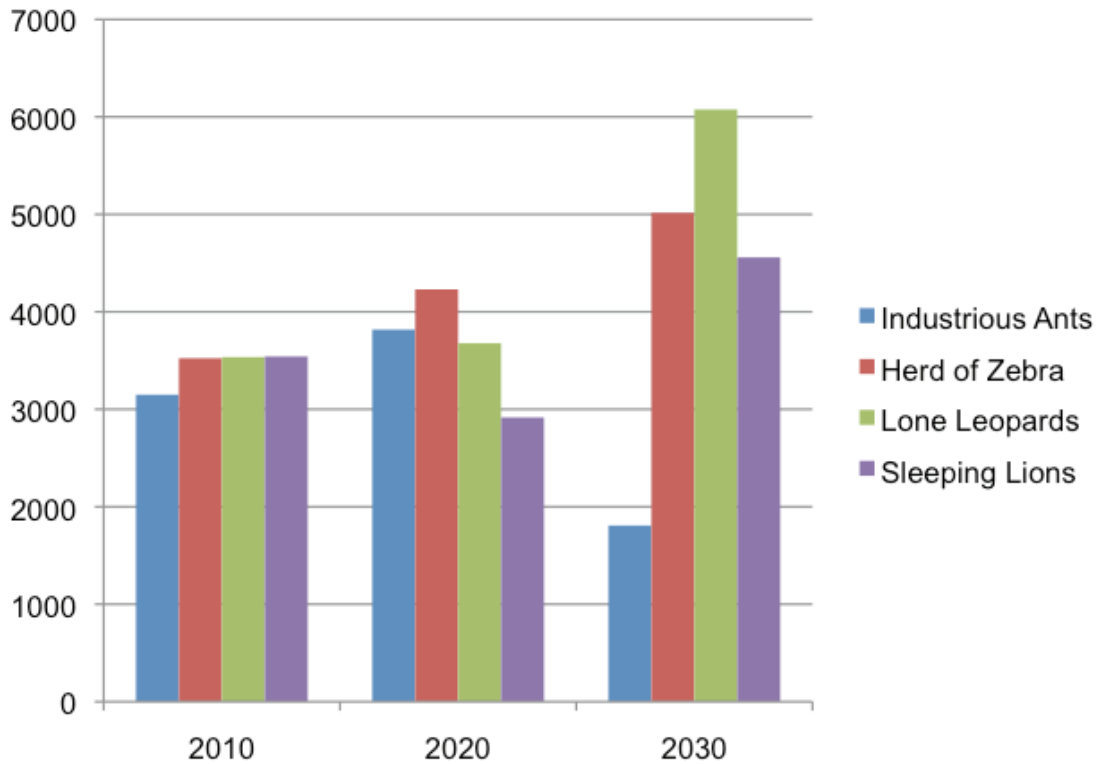


Figure 67. Total additional cropland area per 1000 ha (cropland converted from grassland, forest, or other natural vegetation) from GLOBIOM.

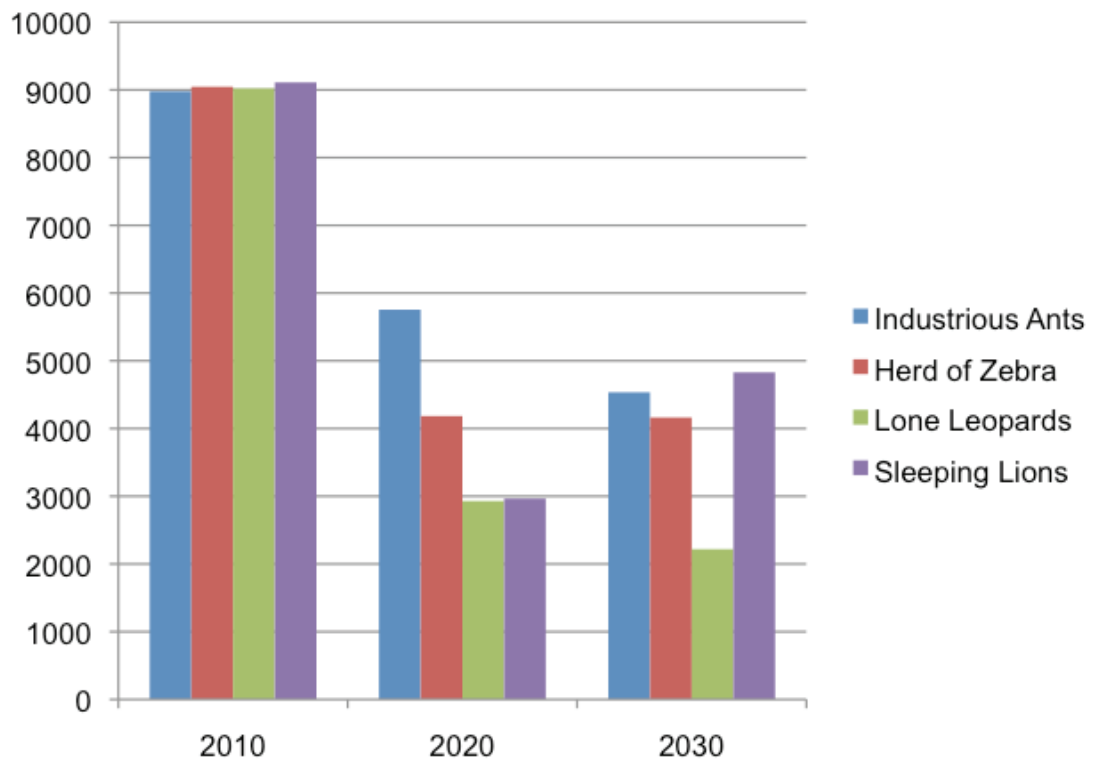


Figure 68. Total additional grassland area (grassland converted from forests and other natural land) from GLOBIOM.

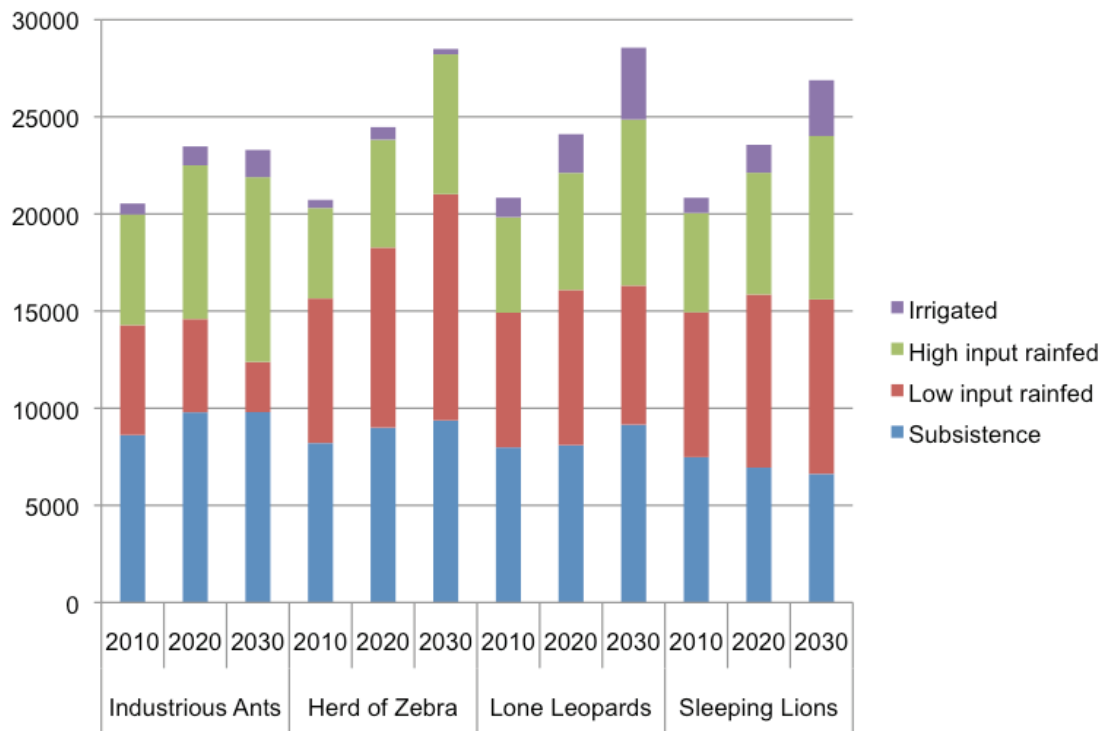


Figure 69. Total area by crop production system from GLOBIOM.

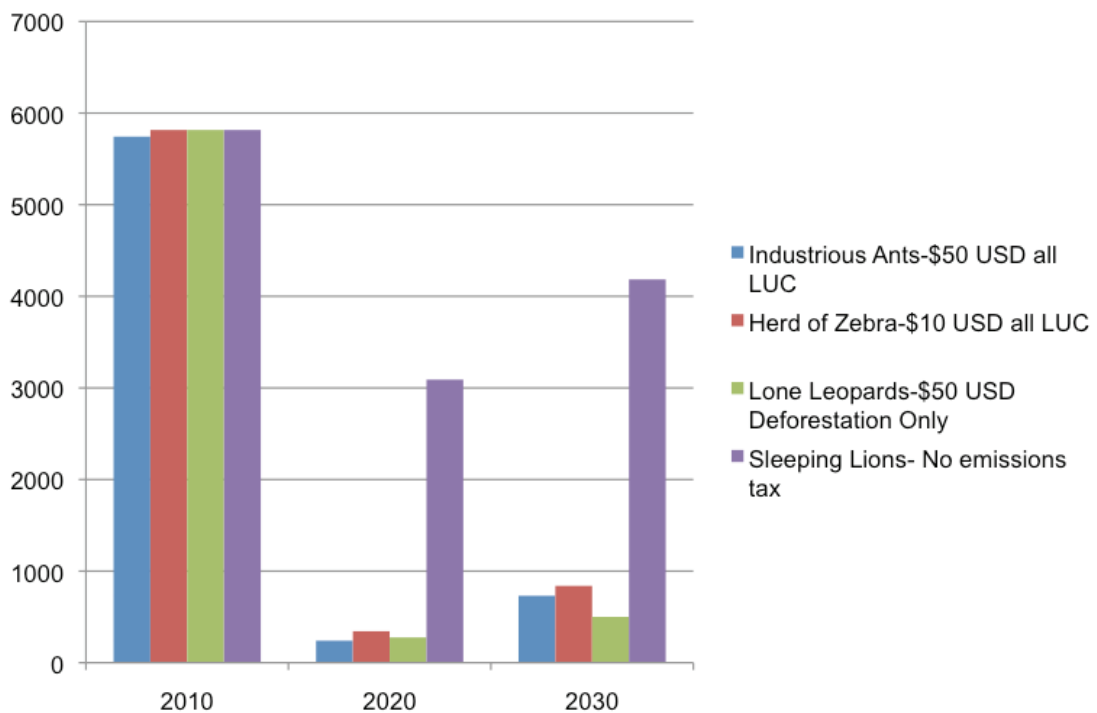


Figure 70. Deforestation under the LUC tax scenarios (forests converted to cropland, grassland, or managed forests) with different emissions from LUC tax regimes for the scenarios: USD 50 per hectare for Industrious Ants, USD 10 per hectare for Herd of Zebra, USD 50 per hectare only applied to deforestation for Lone Leopards and no LUC emissions tax for Sleeping Lions. From GLOBIOM.

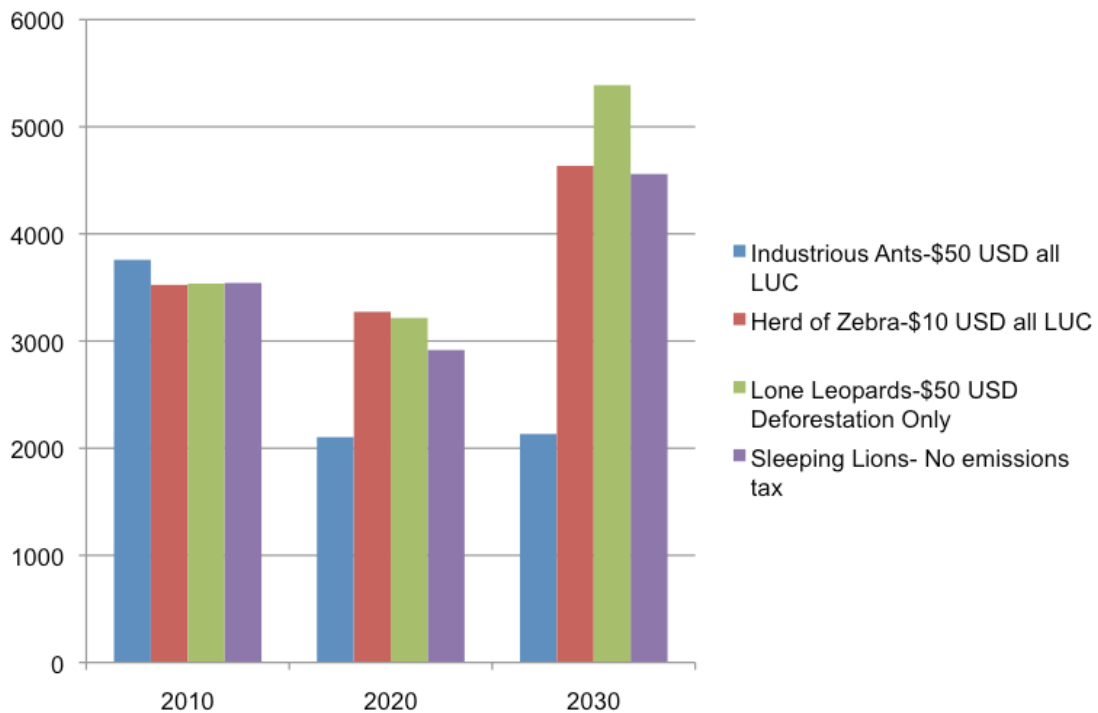


Figure 71. Additional cropland (land converted from grassland or pristine forests) LUC tax regimes for the scenarios: USD 50 per hectare for Industrious Ants, USD 10 per hectare for Herd of Zebra, USD 50 per hectare only applied to deforestation for Lone Leopards and no LUC emissions tax for Sleeping Lions. From GLOBIOM.

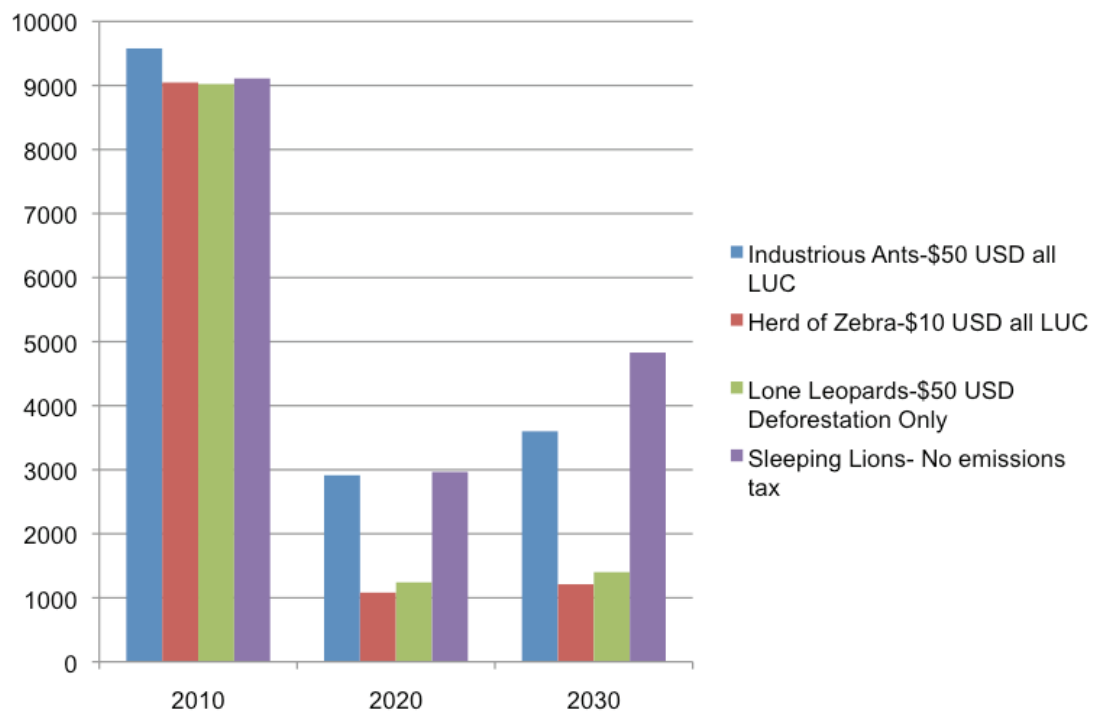


Figure 72. Additional grassland under the LUC tax scenarios from GLOBIOM.

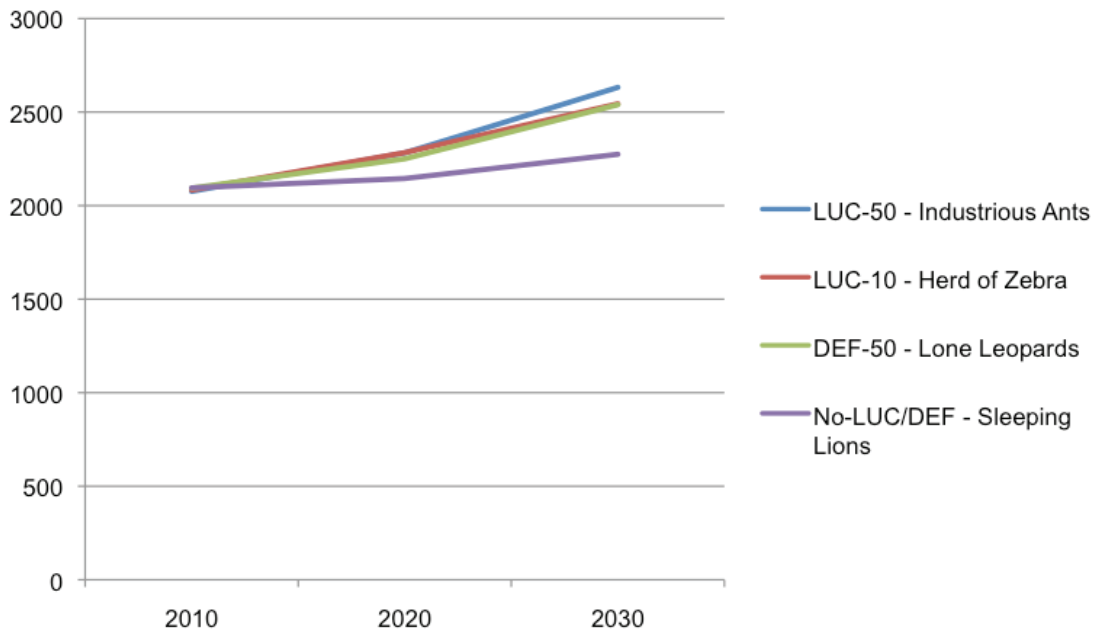


Figure 73. Calorie availability with different LUC tax regimes for the scenarios: USD 50 per hectare for Industrious Ants, USD 10 per hectare for Herd of Zebra, USD 50 per hectare only applied to deforestation for Lone Leopards and no LUC emissions tax for Sleeping Lions. From GLOBIOM.

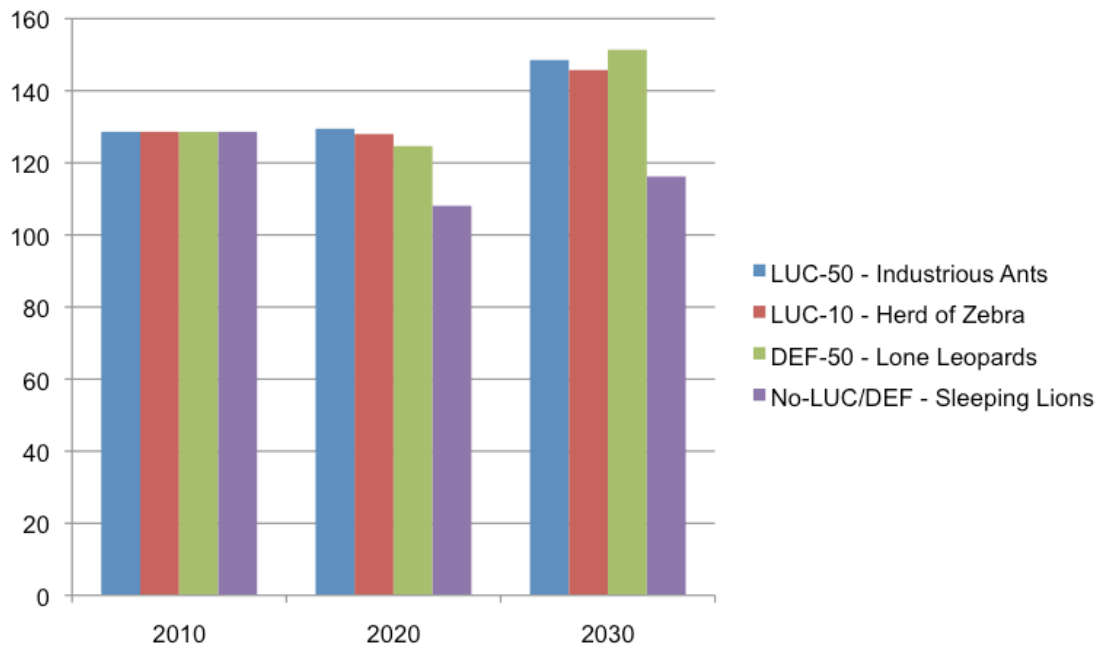


Figure 74. Animal calories under LUC restrictions from GLOBIOM.

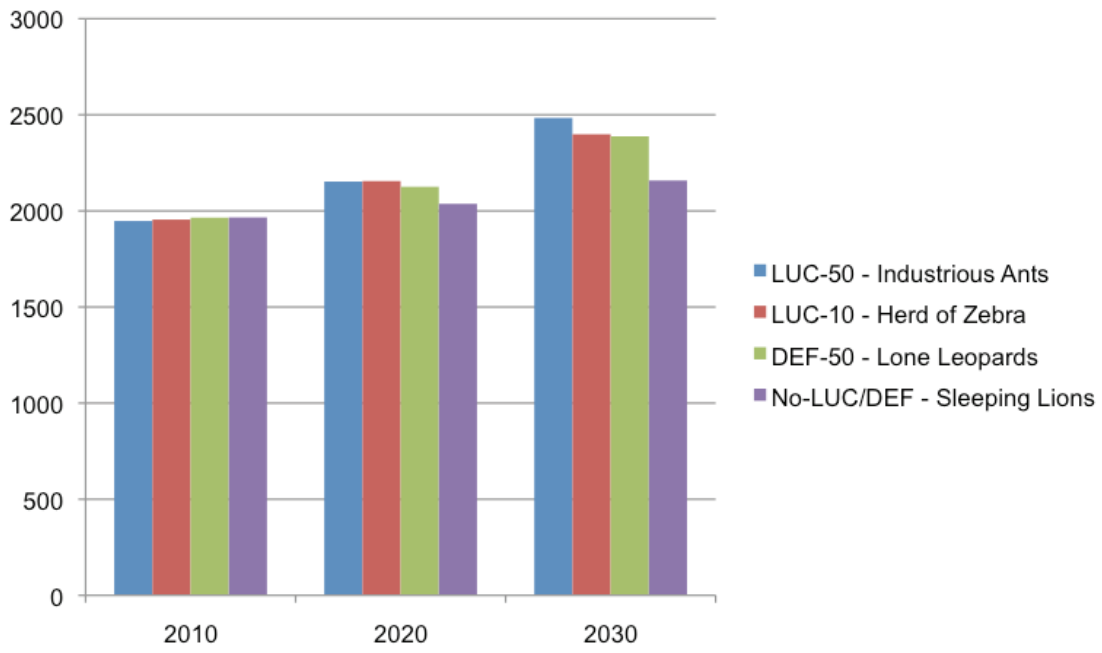


Figure 75. Total vegetable calories under LUC restrictions from GLOBIOM.

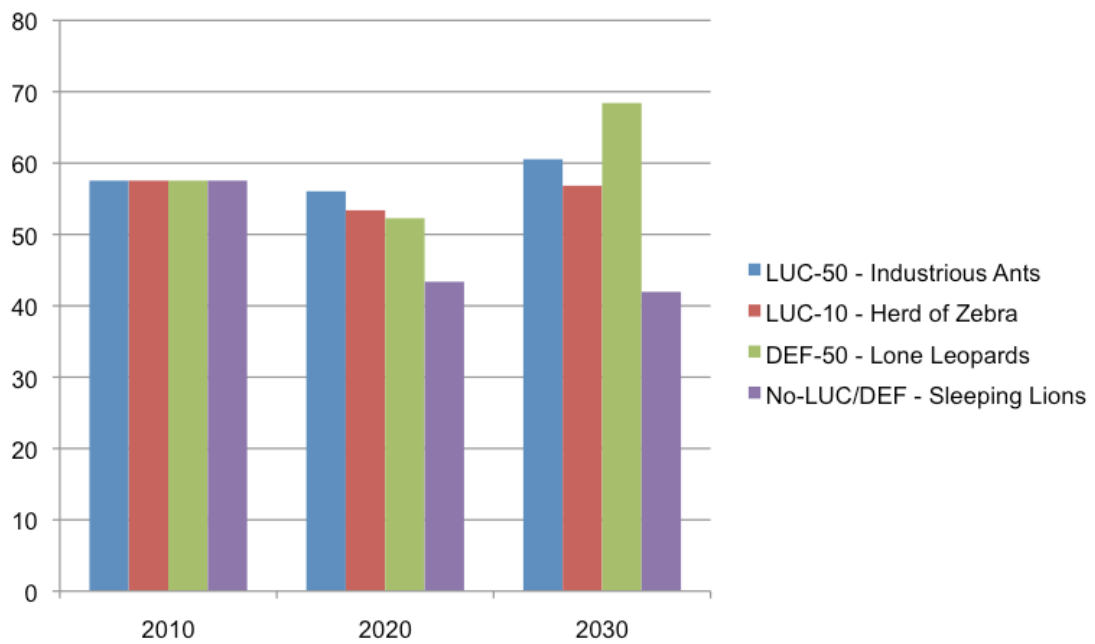


Figure 76. Milk calories under LUC restrictions from GLOBIOM.

Discussion

Key results and insights from the scenarios

The large amount of qualitative, semi-quantitative and quantitative results associated with the CCAFS East Africa scenarios yield a number of insights for the future of the region that are summarized here.

The quantitative analyses indicate that, even with highly proactive policies, global market pressures and changing populations will make it difficult to improve upon the current level of food availability. Therefore, if increasing calorie availability through increasing production or decreasing demand, food policies should be looking into food access and how the food insecure are able to become more food secure. Price supports when shocks occur could be considered. Cost-reducing policies that look at infrastructure can help increase the ease of import as well as enabling food producers to reach markets easier.

Growing populations (the same across all scenarios) and GDP (different for each scenario) drive demand for many food products. In particular, demand for poultry and milk increases with changing consumption patterns due to increases in income (often in urban contexts) in the region.

Foreign investments can either further damage or transform food security in East Africa, depending on how they are managed by regional actors. Investment can contribute to GDP and yields, or can drive displacement of rural populations toward marginal areas.

In all scenarios – even the more environmentally friendly scenarios – food security and livelihoods take precedence over policies for environmental health.

It is, however, possible to minimize the degradation of ecosystems and still moderately increase regional food availability, as the LUC tax versions of the scenarios show. The GLOBIOM results indicate that LUC taxes trigger production into a transformation toward higher intensity production. The taxes would have issues of implementation, however (since the models assume perfect implementation) and governments may have conflicting interests in making revenue from the land use tax and conservation.

Pastoralists face difficult prospects in all future scenarios, even in Industrious Ants where their livelihoods are protected for a time and will move to other sources of income. Confronting challenges around land availability and labour intensity, they may be moving to urban areas. These ex-pastoralists may be among the most food insecure in the cities.

In all of the scenarios, East Africa's demand outstrips production due to increasing populations and GDP to different degrees. This means that in all the scenarios, East Africa will be importing many commodities. Because of this, how East Africa interacts with global markets will be crucial in the future, to different degrees depending on the scenario.

In all East African scenarios, there is a tendency towards increased mixed and intensive agriculture and livestock among small-scale farmers.

Using the scenarios: key results

The East Africa scenarios were used in normative back-casting, with both state actors (policy advisors from different departments, representatives of regional governance

bodies the EAC and the Lake Victoria Basin Commission) and non-state actors (civil society, NGO, representatives of farmers' and agricultural entrepreneurs' associations). In each workshop, participants – largely unfamiliar with the East Africa scenarios since these were developed by others – were first asked to make their normative goals for future food security and environments explicit, as well as to outline what they perceived as their future challenges in reaching these goals through their own organizations.

Then the participants were divided in groups across the scenarios. They were asked to review the scenarios on: 1) plausibility; and 2) relevance to participants' decision making contexts, as well as to adapt them to increase these criteria and link the scenarios to their previously identified challenges. Following this, participants re-examined their normative goals and translated these broader goals into new goals they could personally contribute to achieving. Afterwards each of the groups assigned to scenarios were asked to back-cast from these goals (in 2030) to determine what previous steps were needed (in 2025, 2020 and further backwards) to achieve them. However, the development of these backward pathways did not happen in a vacuum, but in an adaptive fashion with regard to contextual challenges and opportunities offered by each scenario. Then, the pathways developed in the context of different scenarios were evaluated in terms of their feasibility in other scenarios. In some cases, pathways developed in scenarios with more favourable conditions than others were not transferrable. In most cases, though, core ideas could be implemented across multiple scenarios, but the pathways to achieve them would have to be different – resulting in an analysis of a range of feasible pathways toward improved food security and environmental change depending on the need to adapt to different future conditions.

The outcomes from these two workshops were different but complementary. The non-state actors focused on how to realize practical interventions for increased food security and environmental wellbeing. The four different scenarios offered different enabling or limiting governance environments for these non-state actors to work with. Conversely, the policy advisors mainly focused on how to change the governance environments in the scenarios to create a more enabling space for interventions, complementary to the outcomes of the non-state actors' workshop.

As an example from the non-state actors workshop (Figure 7) in the Lone Leopards scenario (fractured status quo and proactive governance of food security, environments and livelihoods, see Figure 14), national-level, information technology-enabled tree management pathways were developed that did not engage regional bodies. Instead, they included the involvement of various individually cooperative governments and consortia with NGOs/CSOs to work with local communities and, at the same time, strengthen geographic information systems and other IT-based research to guide tree management. In the Industrious Ants scenario – characterized by stronger regional integration – pathways could be developed that directly engaged regional funding and research, while in the Sleeping Lions scenario – characterised by a lack of regional integration as well as reactive governance – governments could not be counted on for support and a more bottom-up pathway was required.

In the state actors' workshop, conversely, the greater focus on changing the governance environment led to very different pathways. An important takeaway from this workshop was recognizing benefits to regional policy through the inclusion of farmers in policy making. These benefits were perceived in all the scenarios considered, regardless of whether the reviewed policies focused on improving food security, the environment or livelihoods. An outcome of the workshop was therefore that the policy advisors

recommended a shift of the role of the East African Farmers' Federation from observers in policy processes at the EAC to having a role in agenda-setting.

Reports from all participants in both workshops state that they were successful in enhancing the abilities of the participants to think more strategically about future adaptive pathways, as well as for all involved to grasp the cross-sectoral and cross-country dialogues and partnerships needed to tackle regional food systems and food security issues.

An example of participants' immediate use of the workshop outcomes included an environmental officer of the EAC reporting that she took the following messages into the EAC budget planning meeting that followed the scenarios workshop.

As played out in the Herd of Zebra scenario, the failure of governments to invest in food security and the environment would have severe negative long-term consequences on both – she recognized that this particular scenario was in fact the one that current national policies were leading towards.

As long as governments within the regions failed to work closely with the private sector and civil society actors, they would continue to have a limited ability to initiate positive change, such as enhancing regional food security.

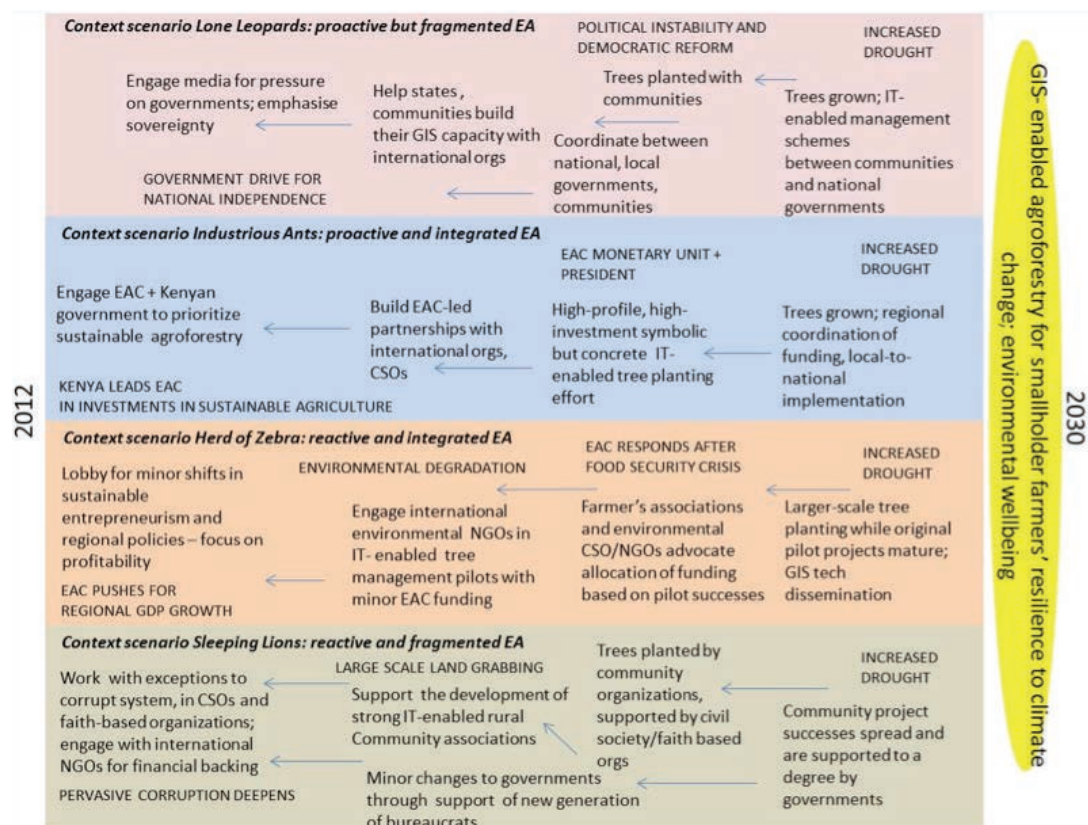


Figure 77. Summary of a strategy from the non-state actors' normative back-casting in the Lone Leopards scenario and how this strategy would have to be adapted to tackle the challenges and opportunities of the other three scenarios. The text in capital letters provides example challenges/opportunities – the sentence case text shows steps in diverse pathways.

Generally, the advisors and other (non-state) participants said that the use of the scenarios in a back-casting process helped them to:

- Take an integrated systems perspective on the future of East Africa.
- Get a better understanding of the future challenges for food security, livelihoods and environments in East Africa and how to design strategies to address these challenges.
- Learn about new regional linkages and find out what activities are being done in other countries – recognizing the need for more interaction between organizations in different sectors and different countries.
- See the need for collaboration between state and non-state actors facilitated by regional bodies.

Participants said they thought the model outputs were tangible and practical and would be useful at the regional, national and local levels. In particular, they felt the outputs would be useful and credible tools for planners and decision makers seeking legitimate information before making choices. After working with the scenarios they found them to be highly plausible. Participants said they will take back what they have learnt to their ministries or agencies and they were keen to advocate the use of scenarios in their planning processes.

A large and diverse set of policy options for state and non-state actors emerged from the workshops as being feasible in most or all future scenarios. Most of these featured collaborations between different national agriculture, environment and planning ministries, regional civil society and private sector platforms in the food security and environment sectors together with the EAC and the Lake Victoria Basin Committee. The policy options also linked to ongoing CCAFS research. Examples are:

- Supporting the East Africa Farmers Federation (EAFF) to have a more proactive and stronger voice in agricultural and food security policy processes, beyond being observers of EAC policy formulation, in order to more effectively serve their member farmers. This was supported by participants from agricultural ministries and other CSOs.
- Setting up a permanent scenarios/strategic futures unit that reports to the EAFF and EAC and provides continuous strategic insight at the regional level in the same way that the CCAFS scenarios process has done.
- Exchange programmes between East African agriculture ministries on:
 - Farmers' schools and associations: first organize exchange programmes between ministries themselves and then between the farmers' associations involved in the programmes. This links to the CCAFS Farms of the Future exchange programme (<http://ccafs.cgiar.org/our-work/research-themes/progressive-adaptation/farms-future>).
 - Knowledge exchange about indigenous, alternative, climate-resilient crops between the ministries.
 - Exchange to learn about urban/peri-urban agriculture programmes between the different EAC countries.
- Developing more inclusive, multi-sector climate communication outlets between the agriculture ministries, the government meteorological offices and the regional media attending the workshop as well as linking to ongoing CCAFS efforts.

- A tree planting scheme between the agriculture ministries, the environmental ministries, the private sector and CCAFS.
- A proposal to the EAC to organize a regional ombudsperson to help ensure more transparent institutions.
- Linking existing Early Warning Systems for food security to regional food reserve planning.
- A West Wing type television series portraying a young dynamic woman leader of a vibrant East African federation – similar to the ongoing efforts featuring agricultural researchers within the region sharing their scientific knowledge with a vast East African rural TV audience through a farm reality show called Shamba Shape-up.

Other general themes of the policy imperatives, options and opportunities discussed in the workshops included investments and efforts towards improving institutional transparency and accountability, media empowerment, civic education, gender roles, agricultural markets infrastructure, alternative energy sources, infrastructure in rural areas to reduce migration, food quality and safety standards and the independence of environmental agencies.

Participants thought that the policy options that came up in the workshops were realistic and implementable, though some would need more attention and support from top officials and additional work to encourage widespread buy-in to these new processes, as well as appropriate financial resources. They also reported having established key partnerships with people in similar roles in other countries, as well as with people from the Society for International Development East Africa, CCAFS and Panos East Africa to consider how to take these policy options forward.

Now, to turn these robust policy options into realities, CCAFS and its partners the Society for International Development and Panos are facilitating the further development of collaborative plans between the ministries, regional bodies and non-state actors identified in the scenarios process. The initial focus for these continued engagements will be on: 1) changing the role of the EAFF in regional policy; 2) setting up a regional strategic futures unit for ongoing support to the EAFF, the EAC and other regional bodies; 3) helping to develop knowledge exchange links between government agricultural, environmental and planning ministries and between governments in the region; and 4) ensuring the usefulness of the scenarios process for national and sub-national decision making. Thus, we are seeing encouraging signs of new joint efforts being made to tackle the complex challenges of agricultural development and food security in the face of many changes, including that of a changing climate.

Using regional scenarios in local futures and vice versa

The regional scenarios and normative back-casting described in this paper are being used in a range of local strategic futures activities, 2 examples of which are discussed below. The interaction between the regional scenarios and local-level futures works both ways: regional scenarios can inform local adaptation pathways, and outcomes can be used to inform and enrich the scenarios and, by extension, regional adaptive pathways.

Local-level scenarios and normative back-casting in a national context

A CCAFS local-to-national level research project, Systemic Integrated Adaptation (SIA), identifies and analyses the links between the resilience and adaptive capacity of smallholder farmers on the ground and the broader social, economic, political and environmental systems in which they are embedded in Africa and South Asia. The programme itself is multi-level,

involving a mixture of intra-community through to national level studies. The regional scenarios processes appraised in this paper are used to provide exploratory examples of how these broader systems might evolve. The regional scenarios are used within the SIA framework to explore what elements farmers might need to adapt to and, through normative back-casting, which adaptation strategies and pathways might be supported or undermined in those broader systems in different scenarios. The combination of regional socio-economic scenarios and climate change scenarios serve as different contexts through which the robustness of back-casted adaptation and development actions is tested. Conversely, the contextual data generated through the integrated multi-level studies in SIA informs the regional level work.

Participatory household-level modelling

The results of the regional scenarios are being used to provide context for much higher-resolution ex-ante modelling, at the levels of the household, community and landscape, linked to stakeholder inputs at that level. While regional modelling efforts informed by regional stakeholders provide aggregated information of the evolution of food systems, household modelling can help in identifying and evaluating different adaptation pathways that work for heterogeneous types of farming systems. At the household level, scenario-specific commodity prices and land-use patterns are used to evaluate the impacts of different future pathways for food security, incomes and key environmental indicators in different types of farming systems.

For example, substantial increases in regional production and price of commodities such as milk in the coming decades may have significant impacts on cropping patterns and farm incomes of smallholder households in some of the mixed crop–livestock systems of central Kenya (Herrero et al. 2014). Evaluation of options at multiple levels helps to identify where social welfare outcomes are at odds with private producer outcomes. In addition, scenario-based household modelling can refine the parameterisation of regional scenarios, providing reality checks on the plausibility of key assumptions such as the extent of LUCs in a particular agricultural system or appropriate changes in stocking rates. A wide variety of different household models are being used for multiple-level analyses, ranging from simple mathematical programming optimisation models (Rufino et al. submitted; Thornton et al. 2011) to models built on systems dynamics and agent-based approaches (Van Wijk et al. 2012).

Links to global futures research

The IPCC-led scientific community has finalized a set of five global Shared Socio-economic Pathways (SSPs), complementary to new climate scenarios or Representative Concentration Pathways (Moss et al. 2010). Simultaneously, several working groups have been created whose main task it is to enrich the basic set of SSPs. A working group on ‘Nested scenarios across geographies and time’ has also been created. This working group will assess possibilities to downscale the global SSPs, taking into account both the geographical specificities and the usually higher temporal resolutions that are considered at regional level. Part of the team involved in the regional scenarios described here is also involved in the development of the SSPs, enabling a cross-level comparison. This comparison, done so far for the East Africa scenario shows that though they have been developed separately from the SSPs, the scenarios nonetheless fit the SSP framework to a degree. The scenarios also differ substantially from the SSPs in that they offer more information and linked dynamics across dimensions and describe regional tensions, challenges and opportunities not perceived at the global level.

Discussion

Reflecting on the scenarios development process

Scenarios methodology is suitable for taking a food systems (rather than an agricultural production) approach to future food security challenges, because it aims to surface and challenge assumptions about actors' wider contexts, instead of limiting itself to their immediate decision space (Wilkinson and Eidinow 2008). The East Africa scenarios process presented in this working paper is an example of this. At the regional level, it incorporates broad socio-economic and political/governance dynamics and explores how these interact with multiple aspects such as food security, environmental change and livelihoods.

However, this broad exploration offers many challenges related to available expertise and data. It has proven difficult, especially initially, to access an appropriate diversity of expertise to inform the futures work, especially when the need for diverse knowledge on food systems and environmental change is combined with the need for participants from different sectors (e.g. governments, civil society) and countries. Initially, the scenarios process in East Africa already engaged various stakeholder groups, but as the required scope of the scenarios became clear, participants in the process highlighted the need for more diverse engagement across sectors and disciplines, including those not directly connected to food security and environments but rather connected to external drivers of change, such as the development of economies and infrastructure and political stability – and the CCAFS scenarios team extended the stakeholder involvement.

Similarly, data availability and compatibility also become challenging with such a broad scope. In our case, the scenarios have been quantified by models that together are only able to deal with a subset of the outcomes of interest, mainly agriculture, basic food security, LUC and emissions. Outcomes related to livelihoods and food quality, for example, have to be addressed in other ways such as the local household modelling.

Linking regional and global scenarios has been demonstrated to be feasible, but still remains a challenge. A single global scenario is currently assumed as a context for the East and West African scenarios. However, what happens to these scenarios when the role of China and India changes? Currently, if we take the example of the East African scenarios, each of these fits an SSP scenario relatively well. However, experimenting with different combinations of global and regional scenarios could provide many new insights. The IPCC SSPs (Moss et al. 2010) invite links to global scenarios but these scenarios are not altered by insights at the sub-continental level. To further develop possibilities for global links, the scenarios outputs are used by the Global Foresight Hub of the Global Forum on Agricultural Research (GFAR 2012) – a global network of food-related futures work and practitioners, as an ongoing example for the network (Vervoort and Ericksen 2012). As the CCAFS scenario planning process in East Africa and in future regions develops, it will be possible to conduct a global-level analysis of contextual challenges and opportunities and adaptation pathways across the developing world, based in the perspectives of regional actors. This can provide key learning between developing world regions as well as providing developing world perspectives on uncertain drivers and adaptation pathways for global development organizations.

Reflections on the scenarios use process

The examples from the state and non-state actors workshops in East Africa show that the combination of explorative scenarios and normative back-casting allows for the sense-making process of developing scenarios to have an assessable role in guiding adaptive decision-pathways. The use of this combinatory process with different groups can create

complementary types of pathways which can be linked and used to link stakeholder groups. The emergence of such outcomes also highlights that there is a long way to go from conceiving adaptation pathways to reflexive application.

In the scenarios development process, participants were continually involved between the meetings, helping to generate credible, legitimate and salient scenarios. In the normative back-casting phase, however, ongoing engagement is essential for another purpose – to help apply the outcomes from the back-casting work into actions contributing to new pathways (Selsky and Parker, 2005). A continual engagement model (Reid et al. 2009) beyond the meetings is key – workshops (over several days) are not necessarily the most effective approach for engaging the highest level decision makers, who are in the best position to turn the ideas generated into actions. Having experienced some limits to the workshop model in East Africa, a key ongoing role of a boundary organization (such as SID) is to continue to strengthen partnerships and turn proposed pathways from state and non-state actors into actions. Strategies such as breakfast meetings between the boundary organizations and participants willing to act as policy champions with higher level policy makers are pursued.

Building long-term partnerships through continual engagement also helps to understand which stakeholders are critical to affect change towards more adaptive decision making and to build relationships with those who are willing to act as policy champions in interactions with top national and regional decision makers. Local partners who are familiar with structures to engage decision makers are best placed to strengthen these links. Another approach that supports a continual engagement model involves training regional experts beyond being veterans of a scenarios process to being able to facilitate futures processes, thus helping to build regional strategic capacity (Reid et al. 2009). In addition to targeted engagement, various outputs with regional communication and media specialists (cartoons, briefs, blogs, films, TV episodes) are being created to engage wider audiences and invite further collaboration (Vervoort et al. 2010).

The adaptations and translations done for the use of the scenarios in normative back-casting with different groups mean that there are essentially different versions of the scenarios, though structured by the same basic assumptions. This willingness to adapt the scenarios and provide scenarios use as a service has enabled such system links to be initiated. However, while the adaptation of the scenarios has provided new critical perspectives on the scenarios, these have yet to be compared and integrated to enrich the scenarios. In addition, the possibility of linking the scenarios to monitoring and tracking via horizon-scanning and the development of early warning systems has yet to be developed (Wilkinson and Eidinow 2008; Wilkinson and Ramirez 2010). This would be a valuable direction to develop to attend to the future in a reflexive fashion and to avoid contributing to a false sense of security (Zurek and Henrichs 2007) and locking into the present.

General conclusions

Scenarios offer a way to make sense of complex systems characterized by high uncertainty. Food systems and their interactions with global environmental and socio-economic change are a typical example of this. In multi-stakeholder contexts, scenarios offer a tool for sharing perspectives on the future and agree on the need for shared action. Planning processes that use both exploratory scenarios and adaptive planning through normative back-casting especially exhibit potential to guide collaborative sense- and decision-making across system levels and dimensions. Planning processes that do not incorporate multiple potential futures still operate under the assumptions of an unacknowledged scenario, and may have limited value in the face of a highly uncertain future. This includes processes that use normative back-casting

exclusively without applying that method in the context of multiple scenarios. Conversely, futures processes that use only scenarios may not help in developing appropriate adaptive pathways. Normative back-casting can help stakeholders explore how to act in challenging future conditions and consider how the pathways developed through back-casting can inform their planning.

The CCAFS program and its partners have created socio-economic scenarios for the future of East Africa up to 2030 together with a wide range of stakeholders. These scenarios provide qualitative, semi-quantitative and quantitative information about each plausible future. Each of these futures offers a different set of challenges and opportunities for decision makers. Additionally, together the 4 scenarios provide insights into common themes, challenges and opportunities for the future of the region. The models used provide complementary and comparable results but are also limited in their ability to capture all dimensions of the scenarios. Qualitative and semi-quantitative information based on stakeholder consultation provides guidelines.

The CCAFS regional scenarios for East Africa have been used successfully in planning processes with state and non-state actors – and the results of these processes have been a number of proposals for collaborative, strategic action to improve food security, environments and livelihoods in the region, taking into account significant socio-economic uncertainties and how these interact with climate change.

More work is needed to turn these proposals into real action. CCAFS performs a guiding role in this process. Continual engagement and embedding of the future-oriented work in the region is vital for this phase to succeed.

In addition to guiding planning at the regional and national levels, the scenarios generated for East Africa also seek to inform local-level planning and research as well as global futures work in research and decision making.

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