

ILRI-FAO Meeting

The Future of Livestock in Developing Countries to 2030

13-15 February, Nairobi, Kenya

Meeting Report

22 September 2006

ILRI-FAO. 2006. The Future of Livestock in Developing Countries to 2030, 13-15 February, Nairobi, Kenya. Meeting Report

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Glossary

ASEAN	Association of Southeast Asian Nations
BSE	Bovine Spongiform Encephalopathy or mad cow disease
CIS	
CFA	Colonies françaises d'Afrique/Communauté française d'Afrique or French colonies/community of Africa
CG/CGIAR	Consultative Group on International Agricultural Research
CJD	Creutzfeldt - Jakob disease
Codex	Codex Alimentarius Commission - organization to develop food standards, guidelines and related texts such as codes of practice under the Joint FAO/WHO Food Standards Programme
CPPP	Community Private Public Partnership
FAO	Food and Agricultural Organization
FMD	Foot and Mouth Disease
FOSS	Free and Open Source Software
GCC	Global Climate Change
IAASTD	The International Assessment of Agricultural Science and Technology for Development
ICT	Information and Communication Technologies
ILO	International Labour Organization
ILRI	International Livestock Research Institute
IP	Intellectual Properties
IPR	Intellectual Property Rights
MA	Millennium Assessment
MDG	Millennium Development Goals
MERCOSUR	Mercado Común del Sur or Southern Common Market
NAFTA	North American Free Trade Agreement
NARS	National Agricultural Research Systems
ODP	Open Development Processes
OECD	Organization for Economic Co-operation and Development
OIE	Office International des Épizooties or World organization for animal health
R&D	Research & Development
S&T	Science and Technology
TRIPS	Trade-Related aspects of Intellectual Property Rights
WIPO	World Intellectual Property Organization
WTO	World Trade Organization

1 Introduction

This report is a summary of a workshop organised by ILRI and FAO and held over three days in February at the ILRI campus in Nairobi. The workshop was designed to be a means of involving specialists and getting them thinking about various aspects of the future of livestock sector development and their implication in developing countries. It involved livestock scientists, colleagues from the private sector and NGOs, and researchers who do scenario modelling including qualitative narratives and quantitative analysis in sectors other than livestock. The objective was to involve diverse experts with a wide range of views and methodological approaches to consider the future of the livestock sector in Sub-Saharan Africa, South Asia, and South East Asia. The aim of this was to understand better the emerging development challenges in these sub-regions and to think about how to build effective linkages between foresight, research, and policy practice.

The workshop was organised so as to include the minimum of presentation and the maximum of discussion. A keynote presentation on “Global Scenarios and Implications for Constructing Future Livestock Scenarios” was followed by short presentations by several participants outlining the major trends that are affecting the livestock sector in different places, and the key uncertainties that make planning for the future very difficult. After discussions about the important drivers of change at work, most of the rest of the workshop was devoted to building story-lines with a livestock perspective, based around the four scenarios originally developed for the Millennium Ecosystem Assessment.

The report starts with a brief overview of scenario building, what it is and what it entails. Section 3 contains brief write-ups of the Millennium Ecosystem Assessment (MA) scenarios. The outputs of the workshop are written up in Section 4, and are the distillations of the work of four separate groups, one dealing with each MA scenario. Finally, in Section 5, a few cross-cutting issues that arise from the livestock scenarios are identified.

It is worth noting that the formulation of the original MA scenarios took many months of work. The livestock scenarios reported here were put together over two days, without the benefit of being harmonised in any way. It is thus not surprising that there is quite a lot of variation in the workshop scenario reports in terms of detail and coverage, and there is not always close correspondence between the MA scenarios and the workshop scenarios of the same name.

In assembling the report, what we have attempted to do is to harmonise the four scenarios using input from the workshop as much as possible, so that the coverage of each scenario is broadly similar. There are some headings that the working groups did not consider explicitly, and for these, where they are judged to be important in adding detail to the story-lines, some text has been appropriated from the MA reports -- these pieces appear in italics in Section 4. The timeline figures were added after the workshop, to help give readers a quick appreciation of the major livestock features of each scenario, as was Table 2, which compares key issues across the workshop scenarios. The text in Section 5, on cross-cutting issues and next steps, was also added after the workshop, to place the outputs in some sort of context. What we wanted as much as possible was a report that was reasonably faithful to the outputs actually produced at the workshop, with a minimum of additions.

We see this report as the first stage in a process that may involve several further steps in the coming months, one of which may be a more formal and complete merging of these scenarios with the MA scenarios, if this is generally deemed to be worthwhile. The real targets of the workshop and subsequent outputs are decision makers in ILRI, FAO and other livestock research and development institutions. The motivating idea behind this work is to force serious, flexible thinking about alternative possibilities for the future and begin to come up with the right mix of strategic decisions that will allow people to adapt to the future. The world has changed dramatically in the last 25 years, and even more and faster changes will happen in the future. The process of doing this work can alter the way we all think about the future and that may ultimately be the most important outcome of the workshop.

2 Notes on Scenarios

This section is taken from Glenn (2006).

A scenario is a story with plausible cause and effect links that connects a future condition with the present, while illustrating key decisions, events, and consequences throughout the narrative.

Projections are often confused with scenarios. Good scenarios include projections and forecasts, discussing the cause and effect linkages of the scenario. Computer models give alternative projections based on different assumptions or inputs to a mathematical model. If one changes inputs to a model, such as grazing patterns, rainfall, disease, fire, etc., then one changes the output of the model in terms of livestock production -- these constitute projections, not scenarios.

Exploratory or descriptive scenarios describe and explore events and trends as they could emerge or evolve from the present to some specific future condition. Each alternative scenario is based on a different set of assumptions such as high or low economic growth, war or peace, and rates of change in various domains such as environmental degradation, technological advances, globalization, etc. Using these assumptions, different estimates are given about common characteristics for each scenario. They can be the items about which the stakeholder is most interested, such as meat or energy consumption per capita, technological changes, or water availability, for example. Specific events are used to illustrate the trends that may influence the future in the scenario.

Normative scenarios describe how a desirable future can emerge from the present. Normative scenarios are based on norms of the stakeholders that clearly illustrate how goals are achieved while using the values of the stakeholders. Very few normative scenarios exist in public. Corporations will sometimes use exploratory scenarios to determine what has to be taken into consideration when writing their internal normative scenario of strategies and tactics. It would be interesting to have alternative scenarios constructed for the future of livestock, and then construct a normative livestock scenario taking all the factors from the exploratory scenarios into account. Good normative scenarios are not romantic dreams about a wonderful future, but describe how the problems are overcome and the opportunities are used to make the preferred future a reality.

The goal of generating scenarios is to understand the mix of strategic decisions that are of maximum benefit in the face of various uncertainties and challenges posed by the external environment. The scenario construction process itself can alter the way participating planners think about the future. Hence, the process of constructing the scenario may be as or more important in affecting decisions than the actual text of the scenario.

Scenarios have been developed and utilized for several reasons, including the following:

- To discover what is unknown that ought to be known, before making decisions.
- To understand the significance of uncertainties.
- To illustrate what is possible and what is not possible.
- To identify what strategies might work in a range of possible scenarios.
- To make the future more real for decision makers to force new thinking and decisions.
- To learn what has to be avoided and uncover new opportunities.

3 The Four Global Scenarios of the Millennium Ecosystem Assessment

The Millennium Ecosystem Assessment (MA; see box 1) developed four scenarios that describe the consequences of different development pathways for ecosystem services and human well-being. The scenarios were designed to explore contrasting transitions of society, as well as contrasting approaches to policies for managing ecosystem services. These scenarios are described in great detail in Chapter 8 of "Ecosystems and Human Well-being: Scenarios, Volume 2" (Island Press, 2005; also available online at <http://www.maweb.org/en/products.global.scenarios.aspx>). These same scenarios are being used as the basis for another assessment, the International Assessment of Agricultural Science and Technology for Development (IAASTD; see Box 2), which is an international effort to evaluate the relevance, quality and effectiveness of agricultural knowledge, science, and technology under different scenarios of the future. The four scenarios were used as background for the livestock futures meeting, and they are described briefly below. Most of the text in this section comes directly from MA publications and information.

Box 1: The Millennium Ecosystem Assessment (MA)

The Millennium Ecosystem Assessment (MA) was an international work program designed to meet the needs of decision makers and the public for scientific information concerning the consequences of ecosystem change for human well-being and options for responding to those changes. The MA was launched in June 2001 and was completed in March 2005. It was designed to help to meet assessment needs of the Convention on Biological Diversity, Convention to Combat Desertification, the Ramsar Convention on Wetlands, and the Convention on Migratory Species, as well as needs of other users in the private sector and civil society. The MA focused on ecosystem services (the benefits people obtain from ecosystems), how changes in ecosystem services have affected human wellbeing, how ecosystem changes may affect people in future decades, and response options that might be adopted at local, national, or global scales to improve ecosystem management and thereby contribute to human well-being and poverty alleviation.

The MA synthesizes information from the scientific literature, datasets, and scientific models, and includes knowledge held by the private sector, practitioners, local communities and indigenous peoples. All of the MA findings underwent rigorous peer review. More than 1,300 authors from 95 countries were involved in four expert working groups preparing the global assessment.

The MA is an instrument to identify priorities for action. It provides tools for planning and management and foresight concerning the consequences of decisions affecting ecosystems. It helps identify response options to achieve human development and sustainability goals, and has helped build individual and institutional capacity to undertake integrated ecosystem assessments and to act on their findings.

Taken from <http://www.maweb.org/en/about.overview.aspx>

The four scenarios can be arrayed along two axes: first, in relation to whether they describe an increasingly globalised or fragmented world, and second, in relation to whether governments and institutions take a proactive or a reactive approach to dealing with environmental problems. The resulting scenarios are shown in Figure 1, and some of the assumptions behind the direct and indirect drivers are shown in Table 1.

Box 2: The International Assessment of Agricultural Science and Technology for Development (IAASTD)

The International Assessment of Agricultural Science and Technology for Development (IAASTD) is a unique international effort that will evaluate the relevance, quality and effectiveness of agricultural knowledge, science, and technology (AKST); and effectiveness of public and private sector policies as well as institutional arrangements in relation to AKST. The essential question to be answered is, "How can we reduce hunger and poverty, improve rural livelihoods, and facilitate equitable, environmentally, socially and economically sustainable development through the generation, access to, and use of agricultural knowledge, science and technology?"

The IAASTD is a three-year collaborative effort (2005 - 2007) that will assess AKST in relation to meeting development and sustainability goals of:

- Reducing hunger and poverty
- Improving nutrition, health and rural livelihoods
- Facilitating social and environmental sustainability

The project is a major global initiative, developed out of a consultative process involving 900 participants and 110 countries from all regions of the world. The IAASTD was launched as an intergovernmental process, with a multi-stakeholder Bureau, under the co-sponsorship of the FAO, GEF, UNDP, UNEP, UNESCO, the World Bank and WHO.

Taken from <http://www.agassessment.org/>

Scenario 1: Global Orchestration

The *Global Orchestration* scenario depicts a globally-connected society in which policy reforms that focus on global trade and economic liberalization are used to reshape economies and governance, emphasizing the creation of markets that allow equitable participation and provide equitable access to goods and services. These policies, in combination with large investments in global public health and the improvement of education worldwide, generally succeed in promoting economic expansion and lift many people out of poverty into an expanding global middle class. Supra-national institutions in this globalised scenario are well-placed to deal with global environmental problems such as climate change and fisheries. However, the reactive approach to ecosystem management favoured in this scenario makes people vulnerable to surprises arising from delayed action. While the focus is on improving human well-being of all people, environmental problems that threaten human well-being are only considered after they become apparent.

Growing economies, expansion of education, and growth of the middle class leads to demand for cleaner cities, less pollution, and a more beautiful environment. Rising income levels bring about changes in global consumption patterns, boosting demand for ecosystem services, including agricultural products such as meat, fish, and vegetables. Growing demand for these services leads to declines in other services, as forests are converted into cropped area and pasture, and the services formerly provided by forests decline. The problems related to increasing food production, such as loss of wildlands, are remote to most people because they live in urban areas. These problems therefore receive only limited attention. Global economic expansion expropriates or degrades many of the ecosystem services poor people once depended upon for their survival. While economic growth more than compensates for these losses in some regions by increasing our ability to find substitutes for particular ecosystem services, in many other places, it does not. An increasing number of people are impacted by the loss of basic ecosystem services essential for human life. While risks seem manageable in some places, in other places there are sudden, unexpected losses as ecosystems cross thresholds and degrade irreversibly. Loss of potable water supplies, crop failures, floods, species invasions, and outbreaks of environmental pathogens increase in frequency. The expansion of abrupt, unpredictable changes in ecosystems, many with harmful effects on increasingly large numbers of people, is the key challenge facing managers of ecosystem services.

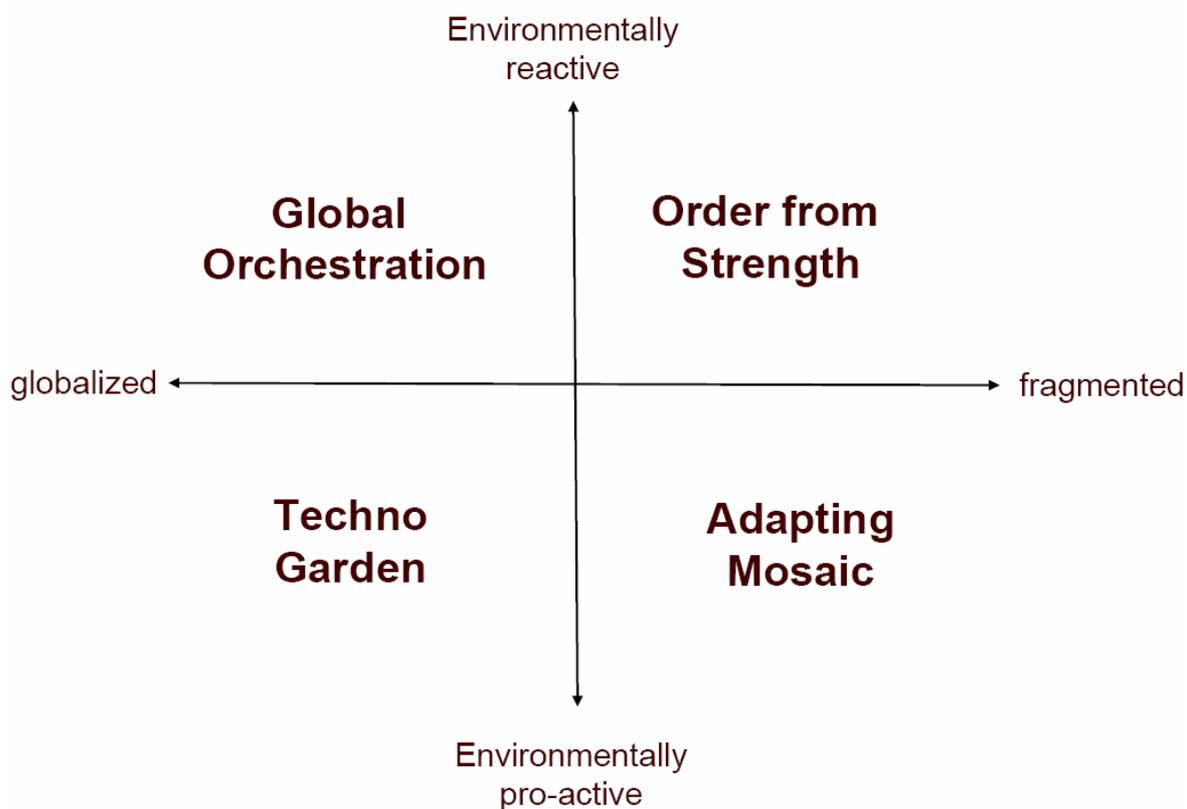


Figure 1: The four MA scenarios

Scenario 2: Order from Strength

The *Order from Strength* scenario represents a regionalized and fragmented world, concerned with security and protection, emphasizing primarily regional markets, and paying little attention to common goods. Nations see looking after their own interests as the best defence against economic insecurity, and the movement of goods, people, and information is strongly regulated and policed. The role of government expands as oil companies, water systems, and other strategic businesses are either nationalized or subjected to more state oversight. Trade is restricted, large amounts of money are invested in security systems, and technological change slows due to restrictions on the flow of goods and information. Regionalization exacerbates global inequality. Agreements on global climate change, international fisheries, and the trade in endangered species are only weakly and haphazardly implemented, resulting in degradation of the global commons. Local problems often go unresolved, but major problems are sometimes handled by rapid disaster relief to at least temporarily resolve the immediate crisis. Many powerful countries cope with local problems by shifting burdens to other, less powerful countries, increasing the gap between rich and poor. In particular, natural resource-intensive industries are moved from wealthier nations to poorer and less powerful ones. Inequality increases considerably within countries as well.

Ecosystem services become more vulnerable, fragile, and variable in *Order from Strength*. For example, parks and reserves exist within fixed boundaries, but climate changes around them, leading to the unintended extirpation of many species. Conditions for crops are often suboptimal, and the ability of societies to import alternative foods is diminished by trade barriers. As a result, there are frequent shortages of food and water, particularly in poor regions. Low levels of trade tend to restrict the number of invasions by exotic species; however, ecosystems are less resilient and invaders are therefore more often successful when they arrive.

Scenario 3: Adapting Mosaic

In the *Adapting Mosaic* scenario, hundreds of regional ecosystems are the focus of political and economic activity. This scenario sees the rise of local ecosystem management strategies, and the strengthening of local institutions. Investments in human and social capital are geared towards improving knowledge about ecosystem functioning and management, which results in a better understanding of resilience, fragility, and local flexibility of ecosystems. There is optimism that we can learn, but humility about preparing for surprises and about our ability to know everything about managing ecosystems. There is also great variation among nations and regions in styles of governance, including management of ecosystem services. Many regions explore actively adaptive management, investigating alternatives through experimentation. Others employ bureaucratically rigid methods to optimize ecosystem performance. Great diversity exists in the outcome of these approaches: some areas thrive, while others develop severe inequality or experience ecological degradation. Initially, trade barriers for goods and products are increased, but barriers for information nearly disappear (for those who are motivated to use them) due to improving communication technologies and rapidly decreasing costs of access to information.

Eventually, the focus on local governance leads to some failures in managing the global commons. Problems like climate change, marine fisheries, and pollution grow worse and global environmental problems intensify. Communities slowly realize that they cannot manage their local areas because global and regional problems are infringing, and they begin to develop networks among communities, regions, and even nations, to better manage the global commons. Solutions that were effective locally are adopted among networks. These networks of regional successes are especially common in situations where there are mutually beneficial opportunities for coordination, such as along river valleys. Sharing good solutions and discarding poor ones eventually improves approaches to a variety of social and environmental problems, ranging from urban poverty to agricultural water pollution. As more knowledge is collected from successes and failures, provision of many services improves.

Scenario 4: Techno Garden

The *Technogarden* scenario depicts a globally connected world relying strongly on technology and highly managed, often engineered ecosystems, to deliver ecosystem services. Overall efficiency of ecosystem service provision improves, but is shadowed by the risks inherent in large-scale human-made solutions and rigid control of ecosystems. Technology and market-oriented institutional reform are used to achieve solutions to environmental problems. These solutions are designed to benefit both the economy and the environment. These changes co-develop with the expansion of property rights to ecosystem services, requiring people to pay for pollution they create, and paying people for providing key ecosystem services through actions such as preservation of key watersheds. Interest in maintaining, and even increasing, the economic value of these property rights, combined with an interest in learning and information, leads to an increase in the use of ecological engineering approaches for managing ecosystem services. Investment in green technology is accompanied by a significant focus on economic development and education, improving people's lives and helping them understand how ecosystems make their livelihoods possible. A variety of problems in global agriculture are addressed by focusing on the multifunctional aspects of agriculture and a global reduction of agricultural subsidies and trade barriers. Recognition of the role of agricultural diversification encourages farms to produce a variety of ecological services, rather than simply maximizing food production. The combination of these movements stimulates the growth of new markets for ecosystem services, such as trade in carbon storage, and the development of technology for increasingly sophisticated ecosystem management. Gradually, environmental entrepreneurship expands as new property rights and technologies co-evolve to stimulate the growth of companies and cooperatives providing reliable ecosystem services to cities, towns, and individual property owners.

Innovative capacity expands quickly in developing nations. The reliable provision of ecosystem services, as a component of economic growth, together with enhanced uptake of technology due to rising income levels, lifts many of the world's poor into a global middle class. While the provision of

basic ecosystem services improves the well-being of the world's poor, the reliability of the services, especially in urban areas, is increasingly critical and increasingly difficult to ensure. Not every problem has succumbed to technological innovation. Reliance on technological solutions sometimes creates new problems and vulnerabilities. In some cases, we seem to be barely ahead of the next threat to ecosystem services. In such cases new problems often seem to emerge from the last solution, and the costs of managing the environment are continually rising. Environmental breakdowns that impact large numbers of people become more common. Sometimes new problems seem to emerge faster than solutions. The challenge for the future will be to learn how to organize social-ecological systems so that ecosystem services are maintained without taxing society's ability to implement solutions to novel, emergent problems.

Table 1: Some of the main assumptions about indirect and direct driving forces across the four MA scenarios

	Global Orchestration	Order from Strength		Adapting Mosaic	Technogarden
Indirect Driving Forces					
		Industrial Nations^a	Developing Nations^a		
Demographics	high migration; low fertility and mortality levels; 2050 population: 8.1 billion	relatively high fertility and mortality levels (especially in developing countries); low migration, 2050 population: 9.6 billion		high fertility level; high mortality levels until 2010 then to medium by 2050; low migration, 2050 population: 9.5 billion	medium fertility levels, medium mortality; medium migration, 2050 population: 8.8 billion
Average income growth	high	medium	low	similar to Order from Strength but with increasing growth rates toward 2050	lower than Global Orchestration, but catching up toward 2050
Investments into human capital	high	medium	low	begins like Order from Strength, then increases in tempo	medium
Overall trend in technology advances	high	low		medium-low	medium in general; high for environmental technology
International cooperation	strong	weak—international competition		weak—focus on local environment	strong
Energy demand and lifestyle	energy-intensive	regionalized assumptions		regionalized assumptions	high level of energy-efficiency
Direct Driving Forces					
Land use change	global forest loss until 2025 slightly below historic rate, stabilizes after 2025; ~10% increase in arable land	global forest loss faster than historic rate until 2025, near current rate after 2025; ~20% increase in arable land compared with 2000		global forest loss until 2025 slightly below historic rate, stabilizes after 2025; ~10% increase in arable land	net increase in forest cover globally until 2025, slow loss after 2025; ~9% increase in arable land
Greenhouse gas emissions by 2050	CO ₂ : 20.1 GtC-eq CH ₄ : 3.7 GtC-eq N ₂ O: 1.1 GtC-eq other GHGs: 0.7 GtC-eq	CO ₂ : 15.4 GtC-eq CH ₄ : 3.3 GtC-eq N ₂ O: 1.1 GtC-eq other GHGs: 0.5 GtC-eq		CO ₂ : 13.3 GtC-eq CH ₄ : 3.2 GtC-eq N ₂ O: 0.9 GtC-eq other GHGs: 0.6 GtC-eq	CO ₂ : 4.7 GtC-eq CH ₄ : 1.6 GtC-eq N ₂ O: 0.6 GtC-eq other GHGs: 0.2 GtC-eq
Air pollution emissions	SO ₂ emissions stabilize, NO _x emissions increase from 2000 to 2050	both SO ₂ and NO _x emissions increase globally		SO ₂ emissions decline; NO _x emissions increase slowly	strong reductions in SO ₂ and NO _x emissions
Climate change	2.0°C in 2050 and 3.5°C in 2100 above pre-industrial	1.7°C in 2050 and 3.3°C in 2100 above pre-industrial		1.9°C in 2050 and 2.8°C in 2100 above pre-industrial	1.5°C in 2050 and 1.9°C in 2100 above pre-industrial
Nutrient loading	increase in N transport in rivers	increase in N transport in rivers		increase in N transport in rivers	decrease in N transport in rivers

^a “Industrial” and “developing” refer to the countries at the beginning of the scenario; some countries may change categories by 2050.

4 The Meeting Scenarios

4.1 Global Orchestration

Introduction

The free-market paradigm dominates for 25 years. Global trade fuelled by widespread liberalization flourishes, with multi-nationals increasing their influence over society. General affluence and the number of wealthy people in the developed world continue to grow, and most emerging economies in 2006 have approached developed status by 2025. But poverty and social exclusion remain key unsolved problems. The global science, technology and research community is polarised into the “global good” and the “consumerisation” factions, with the latter taking an ever more dominant role.

The general dynamic is that “those that can” (both in the private and public sectors) go for short-term opportunities without worrying too much about any but the most obvious long-term repercussions. There are many immediate successes, which fuel global enthusiasm and render those voices trying to draw attention to the longer term problems ineffective and easily marginalised. Global community decision-making bodies (WTO, WIPO, ILO, etc.) focus on areas of easy consensus because the short term benefits (which are presumed will be shared by all) are easy to sell. Indications of longer-term problems are sidelined, on the basis that appropriate technology will be able to deal with any problem.

But most developing countries cannot compete in full free market mode, the gap between them and the developed countries continues to widen, and they are mostly excluded from an otherwise highly connected world. Some alternative development options are found, however, stimulated and supported by the global commons-based community. By 2025, a range of environmental and global climate change problems emerges in forms that are very difficult to deal with, and the affluent world is becoming ever more threatened. Eventually, in 2027, the environment changes the game.

2006-2015: Increasing globalisation

Economic order, social & industrial organization

The Namibia Round of WTO negotiations in 2008 were entered into with high hopes that the developing world’s concerns had been heard, and that an equitable and workable solution would emerge. But between 2008 and 2012 some highly sophisticated (but non-transparent) “divide and conquer” manipulation took place so that by 2012, the push to “harmonise” IP laws (TRIPS) was separated both from the need to find a fairer balance of rights and to put in place exemptions for developing countries until their economies have reached specific levels of maturity. Hence, not long after the harmonisation legislation was in place with only superficial concessions to short-term issues of balance and exemption, those issues fell off the table. The developing world lobby was divided, depending on the size and power of each country’s private sector. The most influential players (e.g. China, Brazil, India, South Africa) became much less active, and the voices of the poorer, less powerful countries were ignored as much of the world experienced sustained growth.

This had major global impact on developments in the economic, S&T and agricultural sectors. In the economic sector, organizations and economies above a threshold level of sophistication continued to grow and thrive. But countries below this threshold, despite spending many years and dedicating their scarce resources in trying to play the free market game, eventually dropped out, creating a subculture of excluded developing countries, the majority of which were in Africa.

Even though there were several objective warnings (see Box 3) of the potential damage to sustainable development, science, and health by the direction of intellectual property rights (IPRs), by 2010 WIPO and WTO had further strengthened and entrenched the ability of individual entities to “own scientific knowledge”, including algorithms, software, genetic and other basic codes of nature.

In the period to 2014, as the impact was felt of the increased free market liberalization allowed by the latest round of the WTO, global value chains began to be established and to dominate world trade. Large multinationals started to challenge and overtake the power of governments and regional bodies in the dynamics of the agricultural sector. The global livestock sector was dominated by a few players once global trade liberalization had eliminated all subsidies for livestock products, including domestic support in developed countries and export subsidies.

Box 3: IP legislation and the need for balance in World Trade, Development, Science, Technology and Innovation

Extract from: "The Wealth of Networks: how social production transforms markets and freedom"; 2006, by Yochai Benkler; Yale University Press; p 328.

Welfare, development, and growth outside of the core economies heavily depend on the transfer of information-embedded goods and tools, information, and knowledge from the technologically advanced economies to the developing and less-developed economies and societies around the globe. These are important partly as finished usable components of welfare. Perhaps more important, however, they are necessary as tools and platforms on which innovation, research, and development can be pursued by local actors in the developing world itself—from the free software developers of Brazil to the agricultural scientists and farmers of Southeast Asia. The primary obstacles to diffusion of these desiderata in the required direction are the institutional framework of intellectual property and trade and the political power of the patent-dependent business models in the information-exporting economies. This is not because the proprietors of information goods and tools are evil. It is because their fiduciary duty is to maximize shareholder value, and the less-developed and developing economies have little money. As rational maximizers with a legal monopoly, the patent holders restrict output and sell at higher rates. This is not a bug in the institutional system we call "intellectual property." It is a known feature that has known undesirable side effects of inefficiently restricting access to the products of innovation. In the context of vast disparities in wealth across the globe, however, this known feature does not merely lead to less than theoretically optimal use of the information. It leads to predictable increase of morbidity and mortality and to higher barriers to development.

Extract from: "Keeping Science Open: the effects of Intellectual Property Policy on the conduct of science"; 2003, by Royal Society working group on IP, Endorsed by the Council of the Royal Society, UK; p VI.

Advances of technology and commercial forces have led to new IP legislation and case law that unreasonably and unnecessarily restrict freedom to access and to use information. This restriction of the commons in the main IP areas of patents, copyright and database right has changed the balance of rights and hampers scientific endeavor. In the interests of society, that balance must be rectified.

The Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS) is intended to harmonize IP laws and facilitate world trade. Whether the flexibilities within it are insufficient, or just insufficiently accessed, is a matter of debate, but it is clear that the benefits that it brings to many developing countries may be outweighed by the disadvantages. We recommend that developing countries should not be required to implement trenches of legislation until their level of development is such that the benefits of implementation outweigh the disadvantages.

The regional trade groups such as MERCOSUR and ASEAN remained important players through the next round of WTO negotiations until free trade was achieved via the removal of tariffs and subsidies. These groups also maintained a function in regional disease control, of especial importance to the smaller players. The African regional bodies continued to play a prominent role for some time, helping their members to harmonize food safety standards and to deal with various livestock diseases. However, they proved ineffective and were unable to help their members even to hold on to their traditional markets in the Middle East.

Dynamics of livestock production and trade

From 2006 to 2010, the process of retail concentration continued in the developed countries with just 100 buying desks controlling access to 600 million consumers. Furthermore, these giants expanded into Asia, Africa and Latin America, creating similar processes of price pressures on producers, and

emphasis on process controls for food safety and quality standards. Soon supermarkets accounted for 80% of retail food sales in developing countries.

Livestock farming transforms from a multipurpose smallholder activity to a single-purpose vertically-coordinated industry. These new organizational forms, backed by institutional instruments, led to ever-higher productivity, lower transaction costs and resulted in group efficiency gains. After some teething problems in the first ten years, they were better able to take advantage of new technologies, e.g. genetic science and biotechnology were widely applied in core production to reduce health risks, ensure safety and raise standards of products. Over time, only a subset of small farmers will survive, and they will be increasingly integrated into coordinated value chains. In the more successful developing countries, large scale vertically integrated and small scale independent producers co-exist, but independent large scale producers will gradually disappear. In most developing countries, especially the poorest, governments lacked the resources to support independent small farmers, who generally lose out to contract farming and large scale production.

Large livestock companies, and particularly the multinationals, focused their foreign direct investment on developing large, integrated livestock operations in major consuming areas, e.g. India, China, and Indonesia. But these investments came with conditions that some countries found difficult to comply with, including the adoption and implementation of developed countries standards (e.g. in animal health, quality standards, and food safety; satisfying requirements for large, consistent deliveries of products), and mechanisms for traceability, quality control and certification.

The global market driven strategy of the multi-nationals resulted in changing supply chains where developing country governments were pressured into adopting regulatory frameworks focused only on the further development of the industrial sector. The changing structure of the livestock sector often resulted in an increase in net meat imports. Many smallholders were not able to participate.

Food safety & livestock disease pandemics

After 2006, rising demand for livestock products, particularly in the fast-growing economies of Asia, combined with a more liberalized global trade regime, transformed global livestock. In the short-term it led to a bifurcation in global livestock sales. In the high-income countries, private sector regulation of the sector led by processors and large retailers drove up not only food safety standards but also environmental and animal welfare standards. Consumer preferences and private sector product differentiation strategies reinforced each other.

In Asia, the low-income consumers that drove market demand were more concerned about price. Nevertheless, food safety scares and the increasing penetration of large retailers increased concern about standards, and even in these markets higher-income consumers were important. Over time, rising incomes shifted concerns in these countries as well.

A landmark food safety crisis occurred in 2008 when a new prion spread via milk was found to have infected at least 80,000 people over a two-year period, mostly in Eastern Europe. The OIE, Codex and WHO were heavily criticized for letting this problem slip through the cracks between them. There was uncertainty over whether it was an animal health problem, a food safety hazard or a medical problem, and therefore whether one or all three organizations were to blame. In response to the recommendations of an external review team aimed at protecting the consumer, the OIE and Codex joined forces in 2009, resulting in a significantly more coordinated approach to global food safety issues.

Livelihoods & poverty

At first, some governments, especially in the fast growing, successful developing countries, were able to ensure that their smallholder farmers remained involved in the value chains, providing the large investors with stable sources of livestock supply. But as the high value market chains become ever larger and increasingly concentrated, many of these smallholders were discarded, and joined their colleagues in the poorest countries who were excluded from the start.

Smallholders in Asia, confronted by increased competition from larger suppliers benefiting from proprietary technology and better infrastructure, adapted as usual. Dairy in Asia took off in a big way. The departure of large competitors from peri-urban areas in the period 2005-2015 due to increased enforcement of environmental regulations briefly offered them a particularly remunerative niche to expand peri-urban production. But rapidly escalating environmental problems in these areas led to escalating financial costs for them as well, and enforcement of outright prohibitions on dumping of waste in waterways. Many sold their farms to urban developers and went into other lines of work. Some bought cheaper and much larger farms in remote areas to begin anew. Some took refuge in supplying exotic products such as the toothed native hen.

In East and Southern Africa, pastoralism as a share of total meat production continued to decline, following the pattern set earlier in West Africa. Medium-size ranches became more prominent in ruminant production, as large ranches were broken up under political pressures and small ones consolidated under economic pressures. Contract farming of monogastric animals became the norm rather than the exception it was in 2006. Dairy production continued to grow, with farm sizes stabilizing at 15 milk cows, after an initial period of scaling up.

In West Africa, imports of meat and milk completely captured the dynamic coastal market and had penetrated to Timbuktu by 2015. Poultry production in coastal countries recovered from severe regional disease threats in 2006-2008, and continued to be strong. Although further regularly recurring regional disease episodes failed to weaken internal markets, they minimized the possibility of developing any export trade.

By 2013, significant areas of Sub-Saharan Africa were being likened to “a giant zoo”, with some of the welcome tourism receipts going into local communities. But this did not prove sustainable in the longer term, as fears developed around local food, and general security, exacerbated by a variety of high profile terrorist attacks in Tanzania, Botswana and Zambia towards the end of the period.

As subsidies decreased and trade barriers disappeared, there was increasing centralization of livestock production in Europe, North America, China and India, based increasingly on high input, semi-industrialized and industrialized production. In addition, animal protein in the Europe and North America was being supplemented significantly by biotechnology- and stem cell-based products. This resulted in over-production, which overwhelmed developing country production, resulting in its stagnation and lack of development, and calls for more debt relief. There was also an increase in “top down” poverty alleviation initiatives, mostly to protect investment and production and to reduce the possibility of wide-spread social unrest and conflict that might cross into Europe.

By 2010, most developed-country governments had abandoned the MDGs, blaming lack of commitment from developing world players for missing the targets in the excluded countries. Politicians in developed and developing countries alike turned away from the concept that smallholder livestock production (even in communal structures) could and should be a major driver of national economic growth by reducing poverty, and providing local employment. Their vision was simple: if you are a smallholder, either become an efficient component of an industrial farming value chain, or leave the land and find alternative employment.

Science & Technology (S&T)

In the global S&T, research and innovation sector, increasing resources were expended in the pursuit of research most likely to lead quickly to IP-based products. The private sector became heavily involved in such research, but objectivity was often a casualty. Criticism and the requests for more in-depth analysis were seen as dissent, and those who stuck to their criticisms were marginalized and stigmatized.

By 2011, the S&T community was divided and polarized as never before, around the issues of knowledge as a global public good that should not be owned by anyone but should be freely available

to all, versus the commoditization of science and research as a driver for free-market-based wealth creation and growth. Research to drive the commoditized S&T was underpinned by a small number of multi-national companies that made their IP available to selected players at a price. This centralized drive in technology resulted in a lack of research to address local issues, and a shortage of locally available trained human resources.

In turn, S&T contributed to the polarization of the livestock industry: those who had access to the technology, those who were willing to take up the technology, and those who operated in an environment that was compatible with the global technology. This created clear winners in the technology push while freehold farmers in the excluded developing countries were the clear losers.

Global climate change

Between 2005 and 2015 the debate over the reality and impacts of global climate change (GCC) became an omnipresent issue. New-generation climate models were able to drill down from the global scale to regional and national levels, and results indicated that previous projections had been underestimated. The incidence, location and severity of extreme weather events became a particular area of research and interest, since the real world was suffering more of such events.

In developing countries, the impact of GCC on smallholders was already extremely serious by 2015, but most responses from the international community were of a knee-jerk nature, involving (nominally) large sums of money and often a high-technology-push approach. But their top-down, public-eye-catching initiatives were mostly poorly designed and coordinated, resulting in little long-term sustainable impact.

By 2014, GCC was significantly destabilizing land-based agricultural production in the south-eastern USA, much of Sub-Saharan Africa, India, and the tropical Far East due to the increased frequency of natural disasters such as hurricanes, droughts and floods. These events led to serious recurring losses of livestock, especially cattle, in most developing countries, where adequate disaster relief for those dependent on local agricultural systems was lacking. GCC also led to increased incidence and severity of disease threats to animals and humans as well as the prevalence of invasive species affecting rangelands. These uncertainties promoted the breakdown of traditional knowledge systems in many developing country communities, leading to the acceleration of the development of more risk-avoidance production systems, particularly industrialized methods.

2016-2025: Phenomenal growth, but not equally shared

Dynamics of livestock production and trade

As feed prices increased due to the elimination of subsidies and increasing meat consumption, those countries with a natural resource base conducive for livestock production (US, Brazil, Argentina, and later Mongolia) had the ability to expand production of feed inputs and therefore increase both production and exports. This production growth was only marginally affected by environmental pressures, despite the growing voice of environmentally concerned NGOs which highlighted a range of issues. But the dominant global media (which had close ties with the multinationals dominating the global agricultural value chains) were able to marginalize these players enough for little attention to be paid by the majority of consumers in the developed world.

Livestock markets became increasingly polarized, with naturally competitive producing countries, mostly through their multinational companies, increasingly supplying the demand of importing countries, particularly those in Asia, through trade or increases in foreign investment. The elimination of subsidies to European livestock producers pushed the region into a net import position for most livestock products. With advances in disease control technology and monitoring, Latin American producers displaced European producers and exporters by 2020. Meanwhile, other net importing countries and regions increased their reliance on imports, including the Middle East and Africa.

By 2016, consumer preferences in the successful developing countries had moved towards those of advanced countries. As a result, many private sector initiatives were devoted to securing the sustainability of agro-food systems. This was facilitated by the use of ICTs to inform consumers about how their specific products were being produced and processed.

By 2020, Asia was dominating livestock markets, displacing the OECD countries. China and India together accounted for a third of global GDP, and living standards had raised so much for parts of their populations that they had become heavy net food importers. This created a vast opportunity for some developing countries to join trade flows of agricultural materials. India and China increasingly sought investment, trade and alliance opportunities in East and Southern Africa. But these opportunities depended on compliance with food safety regulations, and having quality standards and assurance systems in place – few African rural communities had the resources for such systems.

Despite the opportunity for African producers to pick up those Asian, Middle Eastern and African markets previously serviced by Latin America, African trade with the rest of the world remained well below 10%. The development of African livestock industries, particularly those of pig meat and poultry, was increasingly challenged by low-priced imports from more competitive producers. By the 2020s Africa had become an increasingly large importer of staple food for its still-burgeoning populations, and the problems of the control of S&T meant that all developing countries were finding it ever harder to keep up, whilst the excluded countries had long since dropped out. Most foreign aid proved counterproductive since it delayed the need for significant changes essential for establishing self-sufficiency. Many African countries that were excluded from the global community experienced ongoing political instability, as well as unpredictable law enforcement and monetary policies.

By 2018, in the successful developing countries, significant collaboration between the dominant agricultural multinational companies and national governments was a prominent feature, although there was little doubt which was really in the driving seat. Equally prominent was the exclusion of both local governments and community stakeholders. Hence the “bottom-up” channels were effectively blocked, and the stage was set for the poor and excluded communities, even in the most successful countries, to be left ever further behind. With so much success and growth around, the media found it easy to paint these communities as “losers”, who could climb out of their poverty if they really wanted to. Little attention was paid to building local capacity and mechanisms that over the longer term could empower local communities to respond flexibly and strongly to external and potentially negative changes. Local institutions often remained weak, absent or obsolete and therefore non-functioning. This remained the case through to 2030 in the unsuccessful areas in the emerging economies and even in many developed world countries. The poor communities (rural and urban) in these countries continued to receive from the international community the same type of top-down, superficial aid that dominated the 1980-2006 period, with similarly poor success rates. In addition, the dominance of industrial farming in most developing countries meant that land property rights were seldom handled with equity in mind, but rather in the interests of global market competitiveness. Wealth distribution remained distorted, and the gaps between the haves and have-nots grew.

Livelihoods & poverty

Some of the poorest, excluded countries, once they had given up trying to overcome the barriers preventing them from joining the globalised world (about 2018 onwards) started to look for alternative solutions, sometimes with active government involvement, but often via local community-based learning-by-doing initiatives. The influence of the “commons-based” research community could be found in many of these initiatives. By the early 2020s, there were many successful (but small-scale and still poorly coordinated) examples of variations on “cooperative” models, characterised by community ownership.

By 2020 in some of the excluded developing countries a few rural livestock systems had emerged that served as the backbone of successful rural communities. A few central governments took note of these locally grown successes and dropped their populist approach. They began to introduce a systems approach for wider deployment based on these successes. By 2028, several common features had

emerged from the various successful farming cooperative models in villages or townships where farmers supply animals to a central structure run as a Community Private Public Partnership (CPPP). They always included communal lands for grazing with the provision of shared water points (usually boreholes). Also, one-stop community service centres were common, including services for pasture improvement, animal health, animal improvement, animal nutrition, and animal genetics, as well as shared community structures, e.g. holding facilities, meat and milk processing facilities, and tanneries.

The mixed fortunes of smallholders continued in the emerging economies. Although the demand-led Livestock Revolution lifted the fortunes of all sizes of farm in Asia, the share of production of pigs and poultry supplied by smallholders began to fall rapidly in peri-urban areas and eventually in all parts of the region. Dairy in Asia had taken off in a big way, with India supplying 25% of world production by 2025 and China accounting for 20% of world consumption. Smallholders continued to play a significant role in South Asian dairy production in 2025.

In Latin America, “small scale” by 2022 had evolved to mean 500 head of beef animals or 100,000 chickens. Such artisan-based operations continued to hang on under vertical coordination in the more densely populated areas of the region. By 2020, Brazil and Argentina had grown to dominate world meat production, and 300,000-ton refrigerated cargo ships regularly sailed from the River Plate to Shanghai.

In West Africa, smallholder milk production with sales to regular customers continued unabated in the Sahelian cities. However, devaluation of the CFA franc in 2020 led to the rapid rise of small-scale ruminant trade with the Middle East, and the rapid escalation of domestic prices in Sahelian capitals. Trade bans with the aim of minimizing animal exports were actively discussed to try to mitigate urban anger, but were abandoned under donor pressure.

But not everything was going well even for the initially successful emerging economies. From 2012, as the widely over-taxed groundwater began to dry up across many parts of India, over 250 million people (mostly smallholders) became virtual refugees in their own lands. Despite its significant growth, India’s economy could absorb less than 20% of these poorly qualified people (many of whom still wanted to farm – they were doing well until the water dried up). The democratic Indian government experienced a range of crises, with no long-term resolution emerging. Meanwhile, the more prosperous Indian states put up hard and soft barriers to prevent significant population migrations, and many turned a blind eye to the starvation and desperation until parts of the country were in undeclared civil war. By 2027, there was global realization that this was to be another “insoluble problem”, with several of the now very prosperous Indian states having so much autonomy that they were virtually independent countries.

In China, as the gap between the rich 600 million and the poor 1.1 billion grew ever wider, the state was held together (superficially) by a variety of autocratic actions. In reality, it had become at least two countries. A federation of highly prosperous city states (and their hinterlands of centralized, industrial farming) existed, with levels of liberation and democratization that made them palatable to the globalised “democratic” community. These areas were surrounded by (but not easily accessible to) the poor rural populations who basically got on with their lives as best they could, adapting and innovating with whatever they had to hand.

In both India and China, significant numbers of the excluded communities became connected to and began to interact with the global commons movements. This helped them share their challenges and problems, as well as their ideas and innovations. It also helped a few million of them to migrate to where “like-minded” communities lived (mostly in other parts of the excluded world, particularly Africa), enabling them to bring their agricultural skills and experience to be added to the mix in their new environments, and amplifying the bottom-up commons-based approach that was evolving in these areas.

In Africa, the “city state” model (but without effective industrial farming) had been a politically incorrect reality across much of the continent since the early 2000s. After globalization was in full, unrestricted swing from 2012 onwards, even in most excluded countries, the capital city and some other major cities put almost all of their national resources (and those of the donor community) into efforts to jump onto the global bandwagon. Despite ongoing media hype of any signs of success, only one capital showed any significant sustainable growth and inclusion (Dakar, Senegal). Meanwhile, the large, neglected rural communities began to recognize (helped by the global commons community) that migrating to the huge urban slums around these cities was a worse option than staying at home. The concept of national states became less and less relevant as more communities began to experiment with and develop locally relevant solutions, but no longer in isolation. They were linked (albeit tenuously) to the global commons community, which was proving an ever growing and powerful resource for those with a community-based self-help philosophy.

Science & Technology

The globalization and liberalization of livestock industries led to the need for S&T to support and address issues associated with the movement and trade of livestock and livestock products across international borders. This was underpinned by the development of new diagnostics, vaccines and therapeutics to monitor and control animal disease. Also, advances in ICTs made it possible to track the movement of livestock products on a global scale. By 2020, 73% of livestock involved in global trade were tagged at birth and issued with a virtual passport that captured all the relevant health and production information relating to the animal that could be accessed via the mass electronic interactive media (the future of the internet and web) anywhere in the world.

Increasing demands for livestock products were underpinned by developments in the grain, pasture and livestock biotechnology sectors that resulted in increases in livestock productivity. The emergence of a livestock feed industry that catered specifically to the needs of livestock production was a by-product. Advances in biotechnology also resulted in livestock products that addressed a wide range of consumer demands including health benefits that were aligned with an ageing population.

By 2013, the “commoditization of S&T” supporters dominated all aspects of the S&T community, and began to churn out large numbers of graduates fully committed to this philosophy. But the “S&T commons” proponents did not disappear entirely. There were many closet “commons” proponents, keeping their heads down, hoping for a change in philosophical climate – survivors, but not agents of transformation.

Tertiary and research institutions in the developing world, being less common and more cash strapped, were less tolerant of the S&T commons “dissidents”, and these institutions became increasingly compliant with the commoditization philosophy. But in the less successful developing countries, some interesting dynamics started to emerge. Their tertiary institutions lost status in the developed world and relevance in their own countries. Intelligent, innovative people in these countries found other ways to educate and express themselves, much more relevant to their own needs and to most of the rest of their society. By 2020 a new type of African leader in both the private and public sectors emerged from these “outposts”, and in larger numbers. They were not “qualified” and therefore not acceptable to the developed world elites, but they were intelligent, pragmatic, and in touch with the needs of their societies.

These people were not completely without a voice or a receptive audience. Highly interactive, mobile internet connectivity was ubiquitous in the developed world by 2016, and even the remotest, poorest communities had levels of connectivity matching that of the elites in 2000. It was set up primarily by global free-market forces. There had been many attempts to control it for a variety of reasons. But the global ICT network retained its autonomy (although to different levels depending on where in the world you used it) because of its original design, and because of several global open communities of interest and practice who had the commitment and expertise to collectively outwit any attempts at control or serious abuse. These communities were extensions of today’s virus protection community,

the Free and Open Source Software (FOSS) movements, and the open standards development communities.

Natural resource dynamics/management

The negative impacts on the environment were growing unabated. Land and water pollution from industrial livestock production were widespread throughout East Asia, part of South Asia, Latin America, the Near East and CIS. Some countries and areas within countries opted out of livestock, and turn to sourcing livestock products from outside their territories, because of land scarcity and environmental problems. But generally, national and local governments addressed their pollution problems on a case-by-case basis, and no significant progress was made in terms of environmental policy harmonization by 2030. However, advanced feeding technologies and comprehensive manure management succeeded in alleviating pollution in some of the more advanced countries in Latin America and East Asia.

Forest conversion into pasture and arable land for feed, particularly in Latin America, continued at only slightly reduced rates. The overall picture was of declining pasture areas and arable land requirements for feed, as a result of land intensification and productivity increases in livestock production. The continuing shift to monogastrics contributed further to reducing livestock's overall land requirements.

The marginal areas of Sub-Saharan Africa and South Asia experienced a further deterioration of environmental conditions, pushing large areas into irreversible degradation, loss of productivity of grazing areas, and finally loss of livelihoods. Sub-Saharan Africa and South Asia were not experiencing enough economic growth to absorb these populations in other productive sectors, causing civil unrest and continuing need for humanitarian aid.

Addressing these issues required at least some foresight from the global private sector, although their preference was to react as problems emerged. In particular, the global insurance industry had been increasingly hard hit by the cost of food safety scares and pollution incidents, and rising insurance premiums had made unregulated production cost-ineffective. National governments also contributed to regulation, assisted by technical support from international organizations.

Global climate change

During this period, the severity of natural resource constraints increased because of the GCC patterns. Increasing competition for natural resources including water, land and energy pushed livestock production into non-traditional production environments. This, linked with close proximity for livestock, humans and native species, led to an increase in zoonotic diseases. In general, there was widespread deterioration of natural resources, and water shortages in particular were generating increasing numbers of conflicts, particularly in the poorest nations.

In 2017, it was “officially” recognized by the scientific establishment that the split in the Gulf Stream identified a decade earlier had become a permanent feature. More than 50% (and growing) of the stream's warm water was turning south-east “early”, i.e. due south of Greenland, and reinforcing the Atlantic's warm surface water circulation travelling from West Africa towards the West Indies. This has a double climatic impact: colder and longer winters in Northern Europe; and even more frequent and severe Atlantic hurricanes.

The dramatically colder and longer winters in Northern Europe had many effects, including the reversal of the reduction in sea ice around the North Pole. What later proved to be an extremely important outcome that, at the time, went almost unnoticed, was the increased migration of people from the Nordic areas (over 2 million in a 6 year spell). Later analyses revealed that these migrants were mostly young, highly intelligent, well educated, and not too well disposed to the dominant commoditization philosophy. So many of these young, commons oriented, globally connected activists appeared in the southern hemisphere, especially the poorer African countries, where not only was there a surfeit of sun, but also the “commons philosophy” that they preferred. By 2040, these people

had had a significant impact on the emergence of a genuine African Renaissance, particularly in the areas of capacity building, innovation, and entrepreneurship.

The more frequent and severe Atlantic hurricanes had huge impacts. By 2018 much of the Gulf of Mexico had suffered the ever worsening impact of frequent monster hurricanes for a decade. It was recognized that the islands and coastal areas had become effectively uninhabitable for half of every year. This resulted in significant population migration. By 2020, the hurricanes had not only reduced Gulf of Mexico oil production from Venezuela and the Southern USA coast by 80%, but also had caused huge capital losses as rigs were repeatedly repaired and rebuilt for a 7 year period until it was finally realized that this problem had become permanent. Surprisingly, it did not push the oil industry into a permanent supply shortage. The global oil security concerns of the early 2000s (due mostly to the volatility around Iraq, Iran and Nigeria) resulted in the oil price more than doubling over a 1 year period, an effect that proved irreversible. This had surprisingly little impact on the ongoing growth of the global economy, but it did succeed in switching politicians, economists and researchers alike to invest significantly in many short- and long-term alternative energy sources.

The switching to alternative energy sources had also been fostered much earlier by increasing energy costs associated with continued population growth and increasing global average GDP. As the known reserves of fossil fuels were rapidly depleting, it was taking a while for the alternative energy technologies to deliver. Good battery storage technology was elusive for two decades, and the nuclear fission option was shut down once and for all by massive pan-European protests in 2012 that led to serious social unrest. The ever-increasing energy and transportation costs fostered a wide variety of localised system improvements, including the use of bio fuels, the efficient capture and use of manure and methane, and coastal energy farms.

2026-2030: Bursting bubbles

Economic order, social & industrial organization

In 2026, it was finally recognized that there was a high probability that the time was imminent when the world would not be able to feed itself. This was driven by a combination of droughts and floods that saw at least 200 million people starve between 2015-2026, with starvation getting closer to the geographical and cultural boundaries of Europe and North America. Food prices were volatile and security poor. Consequently, political instability was building, even in the most developed countries.

By now it was also clear that the commoditisation-driven developed world agricultural industry produced low-price, mass-commodity nutrition which had become increasingly vulnerable to external pressure because of its homogeneity (genetics, management, ownership). In particular, the use of a wide range of new technologies in the livestock sector had developed too quickly between 2000 and 2020, especially in the newly emerging economies (China, India, Brazil), with little consideration of the longer-term effects such as the loss of local breeds.

Livelihoods & poverty

The role, if any, of smallholder farmers in sustainable development was an ever-present concern. In the globalised world, the issue of “how many smallholders should there be, and doing what with their livestock and crops?” was driven mostly by shorter-term market forces and consumer perceptions, mediated by the hidden interests of the major multinationals, and sometimes mildly influenced by local government policies. In the remaining, excluded, impoverished countries, the same issue was addressed by traditional practices in the context of the immediate food security needs of individuals and the local community; the issue was thus much more about survival than about economic growth.

However, the emergence of the “commons-based” agricultural S&T community, linking up with and working with the excluded communities, led to long-term dynamic systems analyses of the optimal types and numbers of smallholders across a range of situations, and elucidated the circumstances for their survival, their sustainability, and their capacity for wealth creation.

Science & Technology

S&T had long been dominated by the shorter-term interests of the global private sector, particularly the multi-nationals. The excluded African countries which were effectively cut off from the global, commoditized mainstream of S&T, eventually responded by developing their own indigenous knowledge. Indeed, after 2020, this was the spur for many African communities to develop their own social, political and scientific structures. They relied heavily for funding and motivation on the development of local and regional trade. This eventually led, after much trial and error and inevitable problems, to low-but-adequate-input agriculture, dependent on indigenous knowledge, the natural heterogeneity of systems, increasingly precious biodiversity; and local adaptations of pre-2020 developed world technologies.

Global research institutions such as FAO and CGIAR had long since taken the commoditization route, and their relevance to the excluded developing world countries had withered away as a result. Earlier, there had been several headline-grabbing “revolts” on poverty alleviation issues by die-hard “commons” proponents, but these had no long-term impact.

By the early 2020s, the research vacuum in Africa was beginning to be slowly filled by local and regional institutions and structures, nurtured mostly by the global, connected “commons” community, and related NGOs and a few maverick foundations. They worked mostly on community-based, learning-by-doing research initiatives with direct, pragmatic goals, but coordinated within much broader systemic frameworks.

Natural resource dynamics/management

Up to 2026, civil strife and even undeclared civil wars (stimulated as always by political and religious fundamentalism, poverty, corruption, and greed) continued to break out with depressing regularity and predictably lose-lose outcomes mostly in the excluded countries. Earlier short-term solutions to widespread fresh water and energy shortages, as well as to “natural” disasters gave the emerging economies the opportunity to continue to grow and develop. However, after 2018, food insecurity increased (especially in India and China) and energy was increasingly scarce. Both the European and USA power blocks became increasingly concerned with their own futures and internal problems. In 2023, it was confirmed that Russia would join Europe by 2028, bringing with it some of the last significant terrestrial oil and gas reserves. As cracks started to appear in the growth dynamics and reward mechanisms of the developed, global-growth world, serious tensions began to emerge, especially in the newly developed societies in China, India, and Brazil. Regional and perhaps global war had resurfaced as a real threat.

The year 2027 was proving to be a particularly bad one, especially for the USA. Predictably, the hurricane season was proving to be the worst ever. By July 2027, Washington had experienced four tornadoes, and the west coast was experiencing the longest drought on record, resulting in Los Angeles and the rest of southern California having to be evacuated in the absence of any water at all. The US economy was creaking under the strain.

Then, in August 2027 the mildly active volcano in the Canary Islands suddenly erupted explosively. There were no immediate deaths and few serious problems because the 9000-meter sea mountain was being monitored by a sophisticated array of land-based and satellite sensors, and the eruption had been predicted within 11 hours. However, what had also been predicted by a small group of volcanologists, but ignored by the “commoditization-based” scientific authorities, was a more than 30% chance of a repeat of what happened when the mountain erupted some 7000 years ago. Then, almost half of the Island mountain cone (the western side) had collapsed into the sea, producing a tsunami of gigantic proportions.

Three hours after the explosive eruption had begun, the cone did collapse, creating a tsunami 19 times more powerful than the Indian Ocean tsunami of December 2004. It devastated the coast of West Africa within 40 minutes, obliterating Dakar with a 40-meter wall of water, and resulting in over 1.3 million deaths. The wave went on to hit the eastern coast of Brazil (50% devastation of Recife and

Rio); the coast of Western Europe (70% of Holland, and 40% of London were inundated, along with many other cities), and the eastern coast of the USA (New York and Boston were devastated by a 20-meter wall of water, while Washington, 100 km inland, was inundated to a depth of 7 meters).

The total death toll was less than 3.5 million, thanks to powerful early-warning systems. But the material and agricultural devastation was incalculable. Estimates for rebuilding New York alone were in the tens of trillions of dollars. The financial and insurance industries were physically and fiscally devastated. The Dow Jones collapsed, followed by the US economy. Inevitably, the highly interdependent, networked global economy had no safety buffers, and it simply evaporated within 24 hours. The developed world was suddenly broke, and more importantly could not feed itself. Much of the global industrialized farming system was irrevocably broken, and within weeks, tens of millions of people in the most developed societies of the northern hemisphere were starving to death. There was no short-term solution, and many more would die, whilst the survivors lived through the kinds of aftermath described 70 years earlier as a consequence of a nuclear holocaust. But there was a longer-term solution, which had been slowly but inexorably emerging via the collaboration of the global connected commons community with the poorest and most excluded rural communities, particularly in Africa, centring on the role of the smallholder farmer.

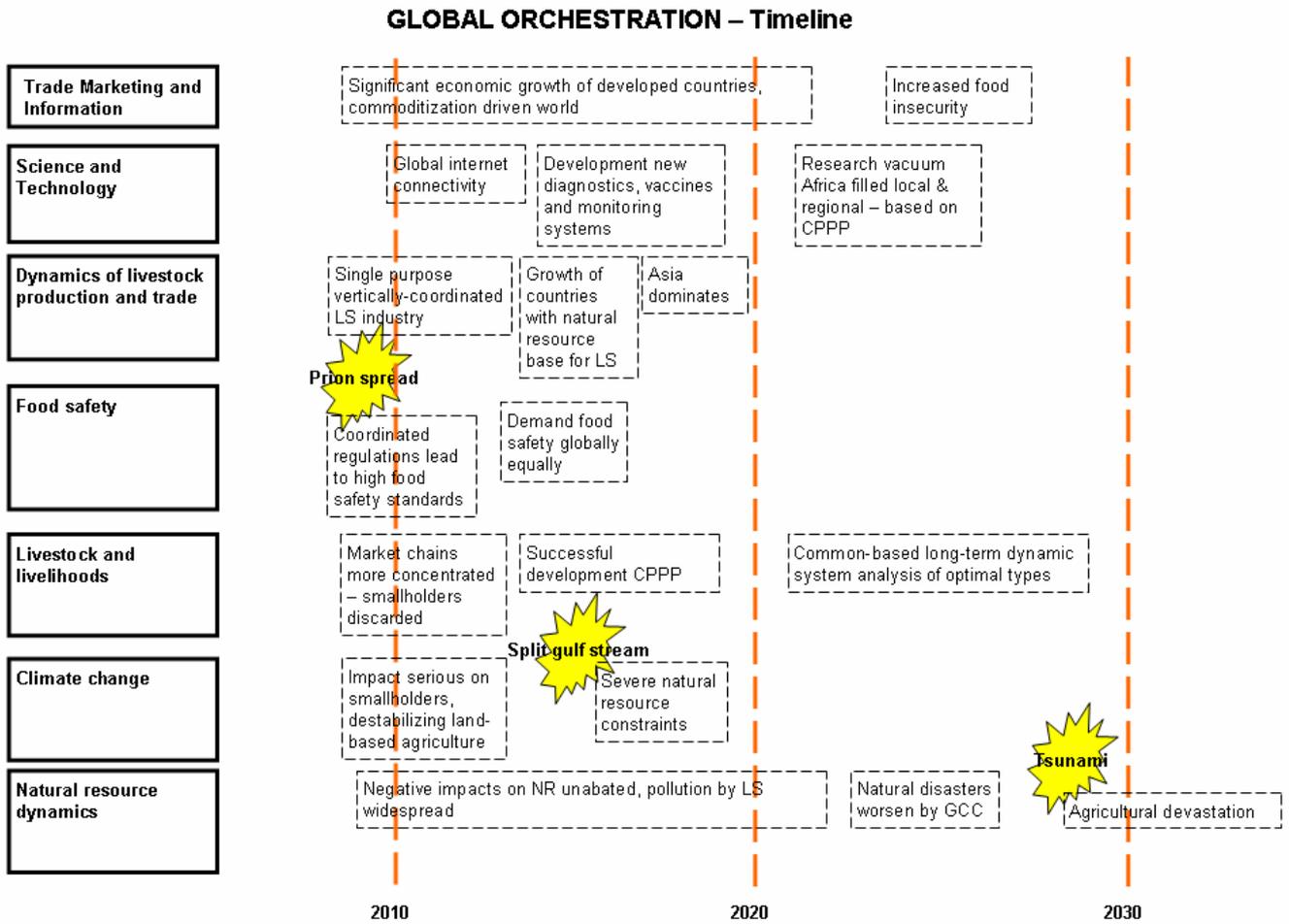


Figure 2: Timeline for the scenario Global Orchestration

4.2 Order from Strength

Introduction

In 2030, the world is a fragmented and polarized place. Governments look to their own interests and there is a marked schism between elites (rich countries and the powerful people within them) and the marginalized. Wealth, power and choice are unevenly distributed around the globe and within individual countries. In this “fortress world”, the levels of political intrigue are high and political alliances shift constantly. International organisations such as FAO, OIE, Codex, WTO, and the CGIAR are poorly funded and largely irrelevant. International agreements are hardly implemented. Because the world is unable to negotiate solutions to disappearing natural resources and climate change, these problems have worsened in the past 25 years. This has placed shared natural resources under stress and made access to them increasingly volatile. Even for people in relatively well-off countries, life is uncertain. For many people in less well-off countries, life is brutal, except for the power elites.

2006-2015

Economic order, social & industrial organization

With increasingly organised and well-articulated protests at each WTO meeting and economic summit, and continued inability to come to agreement on subsidies and other sensitive issues, the Namibia Round of WTO negotiation that began with positive expectations in 2008 finally ground to a halt in 2012 and the decline of the WTO began. China, a rising force in the global livestock sector, continually refused to join the OIE, having determined that it did not need to because it had no plans to develop a large-scale export industry. Its own population with slowly rising incomes could continue to consume anything it produced.

Threats of bioterrorism, narrowly averted, brought the UN system under increasing criticism. FAO and other UN agencies saw a continued decline in funding as OECD countries began to draw back and defend their own borders, while countries emerging as a force in the livestock sector concentrated on their national plans and policies. This reduction in its institutional and national support roles forced FAO to withdraw from significant areas. National concerns for security led to nationalisation or strict regulation of key resources such as oil and water. “Big government” was very much back in vogue. Global tension exacerbated the tensions in the expanded EU, but the contrary has been seen in Africa, where regional groups have banded together more tightly. In southern Africa, for example, Zimbabwe’s economy recovered after a change of government and the region became more tightly linked economically as increasing protectionism and regulation in the EU made international markets harder to access.

One-stop retailers (what used to be supermarkets, although they have evolved into many different forms) were selling 80% of food in developed countries. Multinationals controlled much of the market, but their physical assets were decentralised and their strategies for production and market plans were increasingly adapted to national and local conditions. With a reduced level of international trade, supplying livestock products for domestic consumption became increasingly important, particularly in the countries with growing populations. The centralised multinationals learned to place great importance on further stimulating and meeting these needs. Home-grown companies continued to spring up, and those that focused on controlling the parts of the formal urban market not taken by the multinationals were able to thrive. Informal markets around the world continued to be supplied by small scale local producers adapted to local conditions. However, the risks associated with food security and disease control were high for both consumers and producers alike.

Dynamics in livestock production and trade

Agricultural productivity increases led to a wide range of cheap food being available in many parts of the world, and livestock productivity increased markedly as a result of the increasing demand for food. In developed and developing countries alike, the mixed systems moved increasingly towards corporate ownership.

International trade in livestock products fell steadily in volume from 2010 to 2020, and stabilised at about 65% of 2005 levels, suffering from the decline of international standards, negotiating processes, the raising of bilateral standards, and a general fall in international investment, trade and travel. At the same time it became highly competitive, niche markets were very important, and bilateral agreements predominated, driven by animal health and food safety concerns. A few multinational livestock processors and retailers heeded the warnings contained in the international agricultural assessments of the early twenty-first century, reviewed them in their own scenario building processes, and made contingency plans for the worst case. They survived, now leading what is left of world trade and having a powerful influence on bilateral standards setting.

Global trends moved steadily toward fewer cattle, more goats and camels, plus indigenous species and game, to accommodate the increasing scarcity of water and feed. With no orchestrated responses to climate change, natural resource conflicts (water, land) were common. After a regional war nearly broke out in the Horn of Africa in 2010, movement of livestock in this area was regulated by local leaders and fiercely policed by individual communities. Disputes among livestock keepers in West Africa were regulated and settled (or not) on a highly ad-hoc basis. Marginal areas were in real trouble and common grazing resources were severely eroded. Particularly severe droughts and floods killed many animals, including the indigenous animals that were better adapted to harsh conditions, and these have been hard to replace. Game farming and ranching increased markedly in areas where even indigenous domestic stock found it hard to survive.

Livestock disease pandemics

As the threat of a flu pandemic faded, the donor community switched financial support from global control of transboundary animal disease to other emergencies that more immediately threatened its own borders. Rinderpest returned to East Africa after the failure of vaccine delivery programmes in 2008-2010. This failure was brought about by the return of political unrest in Sudan and continued problems in Somalia, which allowed the disease to spread within those countries and spill over into northern Kenya. The spread was exacerbated by extended droughts that resulted in significant human and livestock migration south and west out of northern Kenya. Since 2006 there were continuing problems with foot-and-mouth disease (FMD) outbreaks in previously free areas, including the USA (a suspected infection from Latin America caused bad relations for many months). Infectious disease control in livestock on a wide scale was increasingly being seen as “impossible”. But India managed to control FMD, following an internal road map set in place in 2005 and based on the OIE pathway. Some other countries had good control, but at a large cost in surveillance methods, which were also needed for certain specialist export industries. In the OECD countries, widespread culling became politically unacceptable as a means of disease control, but marker vaccines made it possible to export vaccinated animals. Shares in vaccine companies soared as a result.

In 2008, BSE was discovered in Brazil at the same time that 15 people in the UK were found to have been infected with variant CJD by blood transfusion. In 2009, FMD mutated to a form that infected people who consumed unpasteurised milk or poorly cooked meat with persistent herpes-like symptoms and caused an outbreak in the UK. It was very quickly stamped out, but there were continuing fears that something like this could happen again. These two events fuelled further insecurity about livestock products and a drop in demand in the EU and the Americas.

Livelihoods and poverty

In affluent and well-informed populations, changing dietary preferences created very distinct market segments for food. Dietary and obesity problems in the USA which have burgeoned since the late 1900s (particularly problems associated with military recruits) inspired more active promotion for reducing animal protein in diets. In 2010 McDonalds introduced the “Fit Burger”, which was 50% vegetable protein and became a lead sales item. In Europe and Australia, there was a divergence between the “slow food” movement that argued for tasty food produced in high-welfare, organic conditions and cooked with care just before eating, and the “safe food” movement that supported low-fat meat produced in sheets from animal stem cells. Among the affluent classes of the industrial and

emerging (Latin America, India, China) economies, “smart food” – Soya impregnated with neurone enhancers, serenity inducers or supplements to prevent hair loss - was meeting the needs of different age and interest groups. Such developments reduced the size of the OECD market for livestock products and made it less dependent on the presence of actual animals.

Meanwhile, the poor, who still existed worldwide but in large and growing numbers in much of the developing world, could not afford to purchase and consume livestock products in large enough amounts to stimulate market growth or to satisfy their nutritional needs. The rural poor tended to produce their own food, subject to the dictates of drought, flood, contamination and livestock health, variations in all of which were being amplified by the local and global effects of global climate change (GCC). Meanwhile, the urban poor mostly survived on a restricted and highly unpredictable diet, which was often scavenged with high short- and long-term health risks, particularly for the very young, the old and the infirm. Where reduced waste was produced from modern-day production and processing methods, even scavenging was restricted, and desperate street children were left with little option but to form roving gangs searching for food, often via theft (frequently targeting the aged affluent population) and even with violence.

Science & Technology

In spite of alarms in the early twenty-first century, a human flu pandemic had not yet occurred, and the H5N1 virus gave way to other forms of avian flu less lethal to humans. The need to face global natural disasters (flu, the tsunami) that temporarily united the international community in the early 2000s was driven back by acts of terrorism and ever-greater vigilance at national borders. A terrorist attack in 2009 was organised and 80% implemented via global connectivity and digital technologies (including nanotechnology), using the Open Development Processes (ODP) mechanisms. It struck seven developed countries at the same time, killing 5000 people, and causing permanent mental damage to 3 million more. This led to draconian measures led by the US, UK and Australia which labelled any ODP activity as terrorism, and sapped the energy from beneficial developments as it tried to control the destructive ones. Many governments spent significant resources on attempts to impose increased regulations and monitoring of the internet and individual movements, but the global ODP community proved to be as resilient as it was nebulous.

By 2015, international livestock research, like almost all other types of research, had largely become the preserve of multinational companies and philanthropic foundations. Typically, the commercial sector would enter into agreement with countries and seek to exploit biological resources for profit, while the foundations funded research in the public domain that had direct and eye-catching impact on human welfare. The CG system was reorganised in 2010, after yet another external review, to multidisciplinary centres serving their regions. When funding levels began to fall, the CG turned to the foundations for funds and human resources. The CG was encouraged to focus on: a) curing human diseases exacerbated by climate change, such as malaria and sleeping sickness, and b) agriculture in conditions of floods droughts and in saltwater. The remaining gene pool of indigenous animals was being plumbed to investigate adaptation to harsh climatic conditions.

National Agricultural Research Systems (NARS) were largely left to fend for themselves. The free flow of scientific information was much restricted by the proprietary approach of the dominant multinationals, so production of international public goods stalled. This meant an increased dependence on indigenous knowledge and local solutions, particularly in many countries of Sub-Saharan Africa and Asia. At first these tended to be very poorly resourced, but the growing strength of regional organisations in Africa was accompanied by regional and local research initiatives for regional and local problems. Much current first-world science and technology (S&T) was only available to the NARS of developing countries as “products”, or via dependency-based agreements. As in the past, these imported “packages” seldom worked as well as promised. However, the S&T component of the global ODP community, though small and often marginalised, was resilient and globally connected. Their strong promotion (via the open implementation of learning-by-doing initiatives) of the commons-based research approach acted as a major support mechanism for the growing regional (and later national) agricultural research initiatives.

Natural resource dynamics/management

(Missing from the workshop; added from Chapter 8, MA)

As the focus of nations turned to protecting their borders and people, so environmental policies focused on securing natural resources. In the developed nations, the belief remained widespread that technological innovations could be brought to bear on environmental problems. Government reactions to natural resources were reactive and ad hoc; and during this period, any measures that were taken merely slowed the degradation of resources and ecosystem function, and delayed the inevitable environmental problems until subsequent decades.

2016-2025

Economic order, social & industrial organization

In this increasingly uncertain world, even regional alliances were coming under threat. The EU failed to develop after a series of problems with countries around accession and a fall in value of the Euro against China's Yuan.

International trade was dominated by cartels and bilateral agreements, with ongoing high costs being expended by both sides on establishing and maintaining the mechanisms to ensure that trade agreements were honoured and standards met. There was increased emphasis and expenditure on enhancing food security, quality and safety within national and regional boundaries, and trade in livestock products was highly regulated.

Global initiatives for the rights of the poor and women became dissipated, and polarisation between the rich and the poor, men and women was still visible in all countries, though in different forms according to local culture and economic development.

Dynamics in livestock production and trade

The structure of the livestock sector came to be increasingly managed and regulated by national governments, bilateral trade partners and large importing and exporting multinational companies, following different patterns in each region. Most countries and regions were forced to be self sufficient and the international trade in livestock that remained was highly competitive. The exception was Africa, where regional trade within the continent flourished. Here, however, shortages of crops and water caused by climate change, and reduced ability to import feed, made it increasingly difficult for the continent to be self sufficient in food, including livestock products.

In most developing countries, there was been a continued trend towards urbanisation, driven by aspirations towards a better livelihood or quality of life, in spite of evidence to the contrary. This left a sharply segmented livestock sector, with the young and old increasingly in charge of indigenous livestock in rural areas, while peri-urban, intensive animal keeping expanded to feed the urban middle class, and the urban poor keeping increasing numbers of animals in slum dwellings. Even bigger governments and increasing regulations were unable to keep urban livestock in check – there were too many of them, and the people who owned them were invisible to formal systems. An estimate made in 2025 suggested that urban livestock in South America outnumbered those in rural areas.

By this time, large regional differences were apparent. For example, Africa was a net importer, mostly of ruminant meat from South America. A small number of countries with high capacity were still able to export into the more challenging markets, but the cost of certifying disease freedom continued to grow and they faced stiff competition and uncertain markets. China and India were largely thrived. India becomes a small net exporter of ruminant livestock products, mostly to niche markets in Muslim countries with Halal meat. But neither country emerged as a global livestock market leader. The barriers to international trade, travel and partnership proved so prohibitive that the predicted “Asian Century” failed to materialise. Latin America was still exporting livestock commodities, but competition was very intense, and countries such as Brazil and Argentina were continually trying to develop specialist markets.

Livestock disease pandemics

In developed countries, livestock disease regulations and control practices meant that disease problems were generally well-controlled during this period. At the same time, however, there was a growing public realisation, fuelled by pressure groups, that control of the spread of disease was driven as much by trade and bioterrorism as by production or animal welfare. The “food within frontiers” movement started to have considerable influence on consumers in OECD countries to buy locally-sourced livestock products.

Livelihoods and poverty

For many of the global poor, food was becoming increasingly expensive because of higher input costs owing to spiralling energy costs, less yield stability associated with GCC, and the lack of public sector investment in research and development.

In addition, with the continued pull to the cities, there was little more investment in rural infrastructure and services in the last 25 years than in the previous 25. Property rights to land were considered in the early twenty-first century to be key to investment in smallholder production agriculture, and some of the more stable African countries made great progress between 2008 and 2015 in granting land title to smallholders. While this certainly provided a measure of livelihood and food security, it did less than expected to expand production and incomes from livestock. The Fresh Farm Food project, started by a coalition of NGOs and civil society groups in 2010, encouraged farmers to form joint ventures, construct small scale processing facilities, and take over from (or work in coalition with) middlemen to supply dairy products and meat to the growing towns. But the slow growth of urban incomes and increasing transport costs proved to be major barriers and only a few of these local ventures were successful. With little investment in veterinary services, infectious diseases continued to be widespread in traditional and marginal systems, while kept at bay by vaccine or very strict compartmentalisation in industrialised livestock value chains.

India’s cattle population decreased but the buffalo population rose, in response to policies put in place 25 years ago. Sheep were replaced by goats as the habitat became drier. Milk and meat production increased, although exports still make up only a very small percentage of production, and the expansion of the poultry industry was thwarted by lack of trade opportunities. While the groundwater lasted, smallholder farmers continued to be strongly involved in livestock production, with some improvements in marketing and food safety assisted by NGOs and local government, although larger commercial enterprises were growing, and states were experimenting with different forms of co-operative and shareholding.

In China, too, the commercial and small scale enterprises grew side by side, although large retailers continued the trend of taking control of urban markets. The “village-ownership” model, developed as an alternative to the co-operative and expanded between 2005 and 2015, allowed small scale producers to connect to formal markets and meet their food safety standards. An essentially federal model developed for government livestock services, with central decision making for emergencies and strong local autonomy for day-to-day decisions.

In East and southern Africa, livestock and the meat industry remained very important in all countries and ecosystems. Due to continuing political turmoil on the continent, the commercial sector developed very little since 2006. In some countries, the economy collapsed completely and disputes over land title destroyed the structure of livestock market chains. Other countries stabilised and recovered or grown slowly, but still had a small commercial sector supplying mostly the domestic and regional markets. Here, people mainly looked for sufficient and cheap food, and the demand for “smart” and highly varied livestock products barely caught on. Smallholders and livestock keepers in communal areas were mostly supply their own needs only.

The political institutions that successfully controlled the commons in the large land masses of Asia for the last 25 years were now coming under real pressure. Several years of severe snowfall in Mongolia

2010 to 2020 taxed relief resources to the limit, and encouraged more people to move closer to the towns and try to become involved in the “white revolution” (the modernising dairy sector). To supply feed to an increasing number of sedentary dairy animals, the common land area was being widely harvested, and the conflict between the remaining transhumant livestock keepers and the newly sedentarised dairy producers started to get out of hand. A decision was made to grant land title to individuals and groups according to their preferred way of life – and quickly, factions formed and accusations of corruption were hurled about. Yet another common resource was becoming privatised.

Natural resource dynamics/management

(Missing from the workshop; added mostly from Chapter 8, MA)

This was a time of considerable environmental decline. Global issues such as climate change were almost impossible to address, as there were always some nations unwilling to cooperate because of narrow national self-interest. Global climate change increased less than expected at the turn of the century, as a larger proportion of the world's population was forced to live a simpler and less materialistic existence. In developed countries, agriculture and urbanisation proceeded apace, at increasing intensities and over greater areas as population increased. Agricultural land use was intensified where it could be, extensified elsewhere, and where problems could not be solved or when areas became highly degraded, they were left for the poor to inhabit.

In developing countries, as populations grew, communities were forced to extend the area under agriculture simple for survival. By 2020, loss of soil, declining air quality, damage from flooding, and decline in coastal fisheries were severe in many poor countries. In some parts of India, for example, exhaustion of groundwater supplies became an enormous issue, and millions of smallholders were adversely affected, causing serious civil unrest and migration in the country.

2026-2030

Dynamics in livestock production and trade

The interaction between livestock and people was now, if anything, more polarised than it was in 2006. For large multinationals and urban populations, livestock products became ever more divorced from the living animal but more closely related to proactive creation of human health. For the Slow Food Movement, livestock products were part of a quality of life linked to holistic food production and sensory appreciation. Competition from an increasingly technological approach to food production, and individual insecurity heightened by a divided world, made the Slow Foodies ever more determined in defence of their quality of life. For the poor, production for consumption remained the norm and there was little trade for cash. Livestock continued to play the part that they had played for decades, contributing to nutritional requirements. Physical assets and social bargaining power were playing a part in the development of rural communities. However, in the countries where conflicts and local tensions and economic instability had already created food insecurity, climate change was making it ever more difficult to produce sufficient food to satisfy the communities’ most basic nutritional needs.

Alongside these changes, the livestock industry quietly continued to grow, in part assisted by the ongoing ICT success, which facilitated the global exchange of ideas and development of technologies and management systems appropriate for the country at the national, provincial and local levels. National livestock policies for over 30 years had been decided by consultation between national and state governments, industry and farmers, but the influence of the formal international community (unlike that of the ODP) had greatly decreased since 2020.

In India, livestock were more important to the economy in 2030 than the picture in 2006 would have indicated. As the world fragmented, tighter holds grew on the movement of information. A consumer backlash in Europe shut down the outsourcing of databanks and related ICT services, but as in Brazil, China, South Africa and the Nordic countries, India’s ICT industry was increasingly strengthened by a major Free and Open Source Software (FOSS) component. This indigenous FOSS-based ICT industry was unrestricted by the patent and copyright barriers that allowed the USA to dominate innovation and

development of the global proprietary software industry since the 1970s. It also plugged India into the global ODP community, which was modelled on the earlier global FOSS movement which emphasised freedoms and their restrictions by non-representative but globally legalised bodies (e.g. WIPO and the WTO). Although embattled by justifiable but misdirected authoritarian fears of the causes and proponents of terrorism, the commons-based ODP community continued to provide an interdependent, freely available global support mechanism for human resource development, innovation, objective research and analysis, free speech, maintenance and support.

Science & Technology

Viable nuclear fusion energy was finally invented in 2025, and strange to say, the breakthrough really did come from a dirty test-tube. This was only just in time, and it came at a huge R&D cost that was borne not only by the private sector but by massive cutbacks in development aid, debt relief and social security programmes in the North. It was still going to take 20 years (i.e. 2045) before the first fusion reactors would come on line, but the technological breakthrough that this represents – limitless, clean, cheap energy – is already being seen on a par with the invention of the wheel.

Despite this, the differences between prospering and other regions were stark. There were continuing downward cycles of escalating poverty, environmental pressures and potential conflict in less industrialised countries. Shorter-term problems were sometimes eased by ameliorative policies and limited investments by richer nations, but the longer-term problems were made worse as the underlying causes were simply not addressed. Naturally enough, this led to increasing resentment of richer nations by the poorer ones, and eventually to conflict as they took violent action. Increased expenditure by the richer countries on security and border controls etc, left little room for the needed investments in human capital and local natural capital.

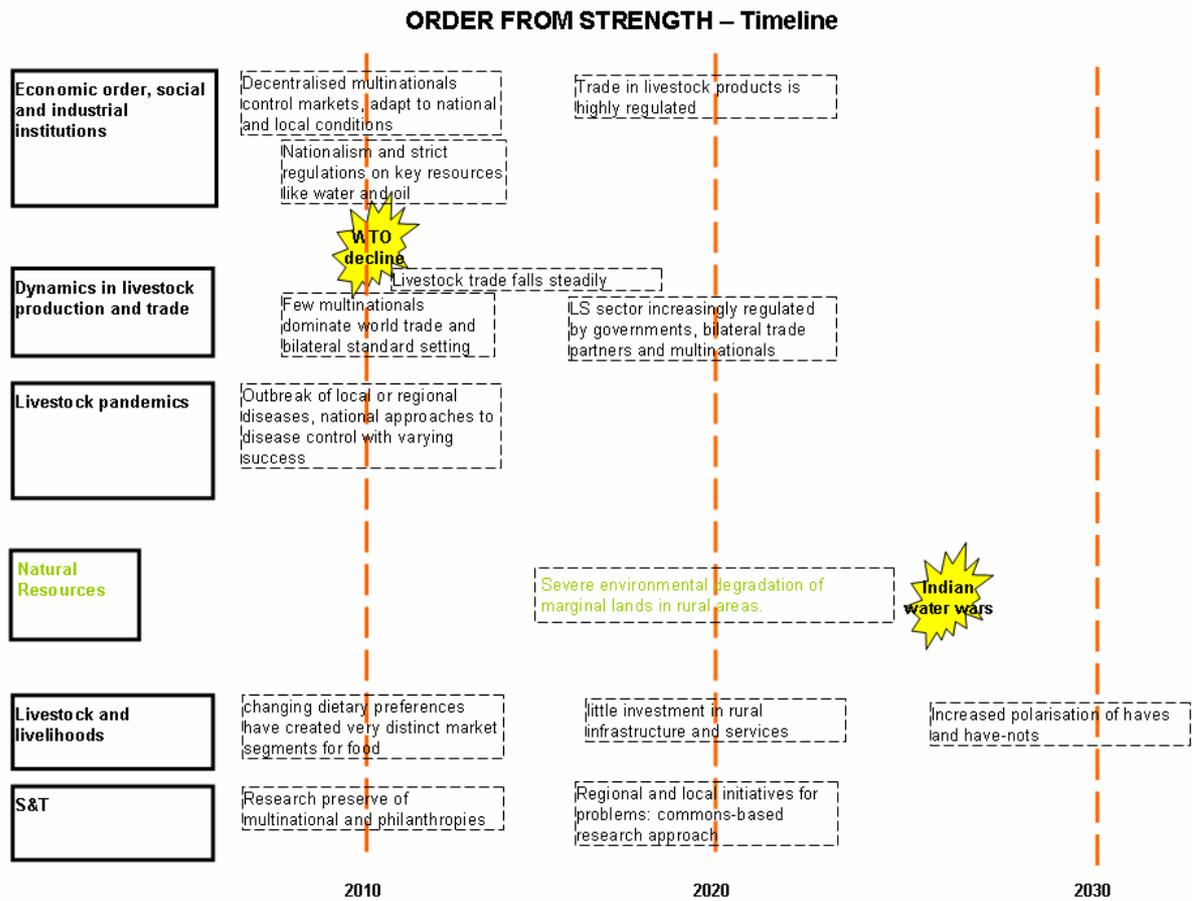


Figure 3: Timeline for the scenario Order from Strength

4.3 Adapting Mosaic

Introduction

In 2030, the world is fragmented, looking more like a patchwork quilt. There are significant differences in economic and political performance between and within nations. Some long-established developed world economies have flourished, but others have stagnated, with declining standards of living, and growing poverty levels, especially in urban areas. Reflecting on these diverging fortunes over the past thirty years, it is clear that pro-active action in learning lessons and in integrating and applying new technologies were key factors in determining different trajectories of livestock systems and their contribution to poverty reduction in the developing world.

2006-2015

Changing economic order

In 2005 global livestock trade was expanding rapidly. Excluding China, where meat product exports declined during 1990-2000, meat product exports experienced growth rates of between 6 and 46 percent per year. But this growth was concentrated in a few countries in Asia. Livestock trade was increasingly regulated by the “free trade” rules of the World Trade Organization (WTO), the strict animal health standards of the Organisation Internationale des Epizooties (OIE), and food safety standards of the CODEX Alimentarius. Although these institutions were dominant in setting and implementing standards in this rules-based economic order, they were not fully coordinating their activities even though it was widely believed that they should be doing so. Multinational companies played important roles in livestock food chains as they become vertically integrated and increasingly concentrated. Many developing countries were not involved in the procedures for setting standards, which were perceived to be increasingly driven by zero-risk preferences of importers, large multinational companies, and affluent consumers in rich importing nations. There were few global attempts to comprehensively address the social equity and environmental consequences arising from the market driven trend toward large-scale industrial livestock production in the developing world.

In some developing countries, rising income levels and urbanization were driving local demand for livestock products, particularly among the newly created middle class. This provided employment and income earning opportunities for livestock producers and other poor people involved with the livestock food chains. However, without strong links to external markets the growth opportunities provided by livestock was largely determined by the size of the local and regional markets, institutional arrangements to ensure low cost-contract enforcement, and the number of retailers who could provide opportunities for smallholders to diversify into more dynamic livestock markets offering high returns. In those countries where markets were small, retailers few, and cost of contract enforcement high, livestock operations were highly risky, with very few firms capable of surviving any significant market or production shock.

Co-evolution of institutions

Between 2006 and 2010, there were several initiatives by a wide range of players (including the public sector, private sector, and civil society) to support the participation of smallholder livestock producers in high value livestock markets. Some smallholder producers were already competitive, but others needed help to become competitive. New institutional arrangements were necessary for providing standards and quality and testing services at the community and village levels to empower small producers. Livestock products (meat, leather products) needed to be of high quality and have strong value added components to serve as engines of growth in local economies. Transport and logistics systems needed to be developed to help rural farms participate in market activities that ensured sustainable, often communal, livestock operations.

Public sector action by governments and their various agencies were dominant in production and marketing of livestock from the post-independence period. Livestock service support and delivery such as veterinary care, breeding, extension, and research were mostly led by government agencies. In many cases where markets were liberalized, the private sector was involved in delivery of veterinary

and other production services but mostly focusing on those farmers who were already competitive. In some cases, non-governmental organizations (NGOs) were helping farmers to become competitive, e.g. via production and marketing services. These uneven and fragmentary linkages between the public, private, and NGO sectors resulted in livestock value chains constrained by high coordination and operation costs and limited innovations to improve the governance and efficiency of the system. The high cost and inefficiencies of these public sector dominated efforts in livestock sector growth were apparent by the year 2000, leading to some developing country governments dropping their populist approach to local level livestock developments.

By 2006 there were several institutional arrangements and partnerships to support local level decision making on livestock sector development. In some developing countries, governments were pro-active in forging new organizational forms involving NGOs and local communities to form Community Public-Private Partnerships (CPPPs) to support livestock development. In other cases, governments formed alliances with private industry. There was great diversity in the outcomes of these two models. Over time, the CPPP model was successful in strengthening partnerships in local communities, learning-by-doing, and encouraging production of high quality products for local markets. However, growth was stifled as these communities were not able to gain access to international markets. Through the efforts of NGOs, local communities started developing bi-lateral and regional networks that promoted trade, and exchange of experience and information within the country and in the regions.

Local communities felt that the alternative government-industry model increased inequality even though it led to high livestock off-take rates from the local community. Eventually this model failed as local communities perceived that the benefits to the communities were less than the benefits accruing to the private companies. Many local farmers felt left out of the system and lost interest in the model. Eventually governments realized that it was difficult to use these top-down public-private initiatives to manage community livestock development. They therefore started developing local networks among communities and adopted the CPPP model that had proved to be successful in community based livestock development in other areas. In some successful cases, governments set up schemes in which the dairy animals belonged to individuals in the communities but government provided specific incentives to the private sector to support the production by local farmers of high-quality livestock products.

Between 2006 and 2010, there was a flurry of partnership arrangements involving a strong private sector role. Where the conditions were right, private companies were working directly with communities using business models to strengthen coordination and improve performance in livestock value chains. In dairy, for example, a few large multi-nationals worked with communities in India, Pakistan, and South Africa to put in place a quality control system that monitored milk quality daily. Each multi-national put in place a milk pricing system that rewarded farmers for producing high quality milk. Working with local authorities, companies were able to train farmers in milk quality assurance and ensuring that high volumes of milk were produced for a demanding high value market. This business model was so successful that by 2010, groups of private companies were teaming up informally to support community livestock development.

Global Financial Institutions that provided the main funds for public investments in many developing countries made the development of Poverty Reduction Strategy Papers (PRSPs) a key requirement for access to donor funds. The conditions imposed by these PRSPs were ubiquitous in many developing countries that were more dependent on donor aid for any kind of public development investment, particularly in Africa, South Asia, and poorer regions of Latin America. In response, governments developed policies and strategies to address issues of economic growth, poverty alleviation and job creation between 2006 and 2010. Livestock issues did not feature prominently in these early documents. However, a substantial body of empirical information on livestock and pro-poor growth in the developing world had been generated. In 2007, the findings from several years of work on the role of livestock in reducing poverty and vulnerability were presented in a landmark meeting. The meeting provided policy-relevant guidance on how livestock can be used to harness growth and design

interventions for faster pro-poor growth. Subsequently, a synthesis of these strategies and options was widely disseminated, with many countries fine-tuning the recommended actions and integrating them into their national growth strategies and public expenditure programs.

Dynamics of livestock production and trade

The inward orientation of livestock production and trade coincided with the rise of strong regional and economic powers in the developing world, e.g. China and India in Asia; South Africa in Africa; and Brazil in Latin America. Increasingly these countries were shaping economic configurations and decision making in their sub-regions.

Demand for livestock products continued to increase in China and India (as in many other places) and by 2010 these two countries accounted for over half of global livestock consumption, particularly for pigs and poultry. Increasing competition for resources (land, water and energy), and consumer backlash against pollution from “factory” farms led India and China to sign several bi-lateral trade arrangements with a number of countries in Africa for livestock supply. China and India however applied OIE and CODEX rules for livestock trade. Several African countries with good potential to export livestock products needed help to meet these standards, so they turned increasingly to African-based research institutes to produce scientific evidence in support of these bi-lateral agreements.

The high demand for livestock in South Africa continued into the first quarter of the twenty-first century as incomes and urbanization grew way beyond the averages for the developing world. The livestock industry favoured strong policies on maintaining and utilizing the local animal genetic pool to counter the threat of loss of indigenous livestock genetic resources observed in other parts of the developing world due to market led responses to livestock sector growth. By 2010, it was clear that the commercial livestock sector in the country was not able to meet the rising domestic demand even though the largest proportion of animals traded was coming from organized auctions involving the smallholder communal sector. South Africa turned increasingly to regional livestock markets (as distant as Kenya and Ethiopia in East Africa) to meet local demand. It set and applied its own standards for livestock trade. In practice there were several standards between the private and public sector, although the private sector standards were more important for trade. The informal market for livestock products proved to be very resilient and continued the strong growth that was observed in the early 2000s. Standards in this sector continued to be based on agreements between producers and consumers until there was a major outbreak of goat-lung virus. This disease grew into a major epidemic that crossed over to humans because goats and humans often live side by side in these communal livestock systems.

Livestock disease pandemic

The rapid growth of the livestock industry worldwide was substantially slowed by threats of livestock disease pandemics. By 2010, avian flu had reached pandemic proportions in much of the developing world. The disease had spread from East Asia where it was first detected and was now wreaking havoc in large parts of Asia and Africa, particularly in those countries with very weak systems for disease detection and surveillance. The world knew a lot more about transmission of avian flu by this time. Credible scientific evidence showed that in addition to migratory birds, poultry trade, and frequent contact between people and animals increased the risk of transmission between and within regions. In the intensive poultry production systems in China and other countries in East Asia, there was a widespread perception that the disease risk originated from and was spread by livestock “factory” farms and their by-products such as feed and manure. Such perceptions led to a backlash against large-scale poultry farms in several major livestock producing countries in Asia.

The years 2006-2010 saw an increasing use of animal health to restrict trade and to block the movement of animals on a global scale. There were heightened concerns about avian flu and outbreaks of several other global animal diseases. Consequently, many countries banned imports of livestock and livestock products leading to increasing reliance on domestic and regional production and trade of livestock. Livestock trade between the developing world and the developed world ceased to exist as livestock markets became more localized aided by fear of emerging diseases related to global trade.

Although a few countries allowed international trade when there was scientific evidence to show that livestock products were disease-free, negative consumer perceptions regarding imported livestock products severely restricted international trade in livestock. Consumers reacted worldwide by sharply reducing most forms of livestock consumption. These reactions led to dramatic price declines, significant reduction in levels of global and domestic trade, and loss of livestock-related income, employment, and protein source for large numbers of poor people in the developing world.

The spread of avian flu and the increasing perception that its transmission was caused by imported frozen poultry and poultry products from large-scale intensive poultry operations in Europe and Asia led to massive consumer boycotts of poultry products in Africa. The local chicken producer association in several large net importing countries such as Nigeria and Kenya lobbied their governments to impose import bans to protect the domestic poultry industry. This led to a trade ban on day-old chicks and finished poultry products from countries that were known or perceived to have avian flu. Such actions resulted in sharp increases in prices of indigenous chicken as consumers switched from imported chicken. At the regional level there was strong support for regional efforts to contain the spread of livestock diseases in developing countries. In Africa a regional meeting organized by the Africa Union in Dakar emphasized the need for a regional approach to check the spread of the pandemic in Africa. Implementation of the action plan drawn up at this meeting was sluggish because of funding and capacity constraints at the national and regional levels. International organizations were providing technical support for country and regional initiatives but limited coordination of these efforts meant that the policy and technical responses were largely ineffective.

Natural resource management

By the turn of the twentieth century, increasing livestock and human populations in the arid and semi-arid areas of Africa and South Asia were putting pressure on feed resources, crops were being grown on pasture land, and there was tension over who had access to pastures and water. Feed resources were scarce and highly variable. Large variations in weather patterns due to climate change were making things worse. The rapid pace of dynamic changes in rural areas was putting pressure on the capacity of traditional self-sustaining systems to cope.

Management of natural resources such as water, available land and feed needed serious revision related to livestock production. Individual farmers were not able to manage local areas well and traditional livestock products no longer had the priority compared with the demands of the urban markets. Smallholder livestock keepers and other poor people dependent on livestock were getting poorer. There were increasing conflicts over access to land and water resources such as grazing points. Some farmers gave up and, in desperation, migrated to urban slums where their lack of traditional community support systems and relevant “street-wise” skills condemned the majority (and their families) to a downward spiral of hopeless poverty, deprivation and squalor, and often fuelled the growing statistics of crime and substance abuse.

With the support of NGOs and scientists, some communities were experimenting with innovative ways to manage land and water resources more effectively. The focus was to build on livestock keepers’ knowledge to develop innovations that would help solve local problems. Successful innovations included technologies to better manage rangeland and water for livestock use, such as the identification of innovative and communally-appropriate ways to manage key dry-season grazing resources, and a choice of easy-to-implement systems that enabled communities to cope with weather variability and to manage livestock across a range of different circumstances. Many of these successes were underpinned by the local communities having clearly defined the rights and responsibilities governing access to and use of common property resources. Implementation of these rights and responsibilities were enforced by strict penalties for those who did not comply.

By 2010, issues relating to degradation of natural resources and the function of ecosystems and their livelihood implications were high on the agenda of local communities. They started questioning efforts to conserve ecosystems because they were perceived to have few benefits for livestock keepers and their communities. These questions prompted increased research by the international community to

generate evidence-based valuation, attribution, and compensation schemes for key natural resources, particularly in pastoral and agro-pastoral areas where large numbers of poor people were likely to benefit. These studies provided relevant guidelines that were tested in livestock communities by several NGOs and development agencies. Many governments learnt from these schemes and by 2015, there was increased payment for ecosystems services such as animal genetic resources and carbon trading, particularly in arid and semi-arid areas of India, Africa, and Central America.

The increase in local experimentation for managing the commons, water resources, and grazing areas was greatly aided by the growth of investments in public and private education and the support some governments, NGOs, and the private sector gave for the use of ICT in addressing national and regional problems that had local significance (Box 4). The decisions by many developing countries to establish universal free education had a positive spin off impact on poverty alleviation and improved livestock management, for example in Tanzania, where the government had innovative initiatives to provide universal education and practical skills development for all girls by 2015.

Science & Technology

From 2006 to 2010, science and technology (S&T) and research remained in “business as usual” mode. Low crop and animal productivity and food production problems continued in Africa, while negative social, environmental, and public health externalities characterized the industrial livestock systems common in Asia and Latin America. Increased advocacy by international organisations raised awareness among the general public (especially in the developed world) on the major environmental, public health, and equity impacts of rapid livestock growth in the developing world. This led to societal and political pressures and a major international consensus that livestock should be managed differently by major global and regional players.

By 2010 the CGIAR had re-aligned its strategic focus to emphasize a stronger development agenda that better served local and regional needs. The decision by ILRI in 2006 to develop major livestock platforms for diagnostics and development of vaccines was paying off. Some of the diagnostic products were used widely in India and East Africa, providing quick and practical tools that helped poor livestock keepers and their communities to evaluate milk quality at village collection sites. The procedures and lessons learnt from the development of a genomics-based vaccine for East Coast Fever were synthesized into a livestock platform which could be routinely applied to other major livestock diseases. The networks developed in these platforms provided important mechanisms for learning and sharing lessons on which diagnostic tools were having greatest impacts, why, and on what stage of the livestock food chain. This information provided a valuable sourcebook for livestock scientists and development practitioners.

Despite these successes, there was a growing perception within many developing countries, particularly in Africa, that S&T was not being used effectively to support livestock systems development. These perceptions that the organization and management of S&T were not meeting the development and environmental needs and objectives of developing countries led to the growth of non-governmental and local actions resulting in changes in governance situations that were more adaptable to community realities. For example, the findings of a Task Force report on S&T in sub-Saharan Africa prompted calls for changes in the governance of S&T in the region.

A few developing countries started experimenting with new forms of S&T management and established networks and interactions with S&T institutions in China, India, and Brazil, thereby gaining access to major research results which they perceived to be more relevant to their development needs. In Africa, NEPAD championed the formation of sub-regional centres of excellence in S&T where scientists from all over the region came to undertake research (often on a seconded or part-time basis). In contrast, other developing countries closed off their S&T with unchanged policy objectives, leading to slow technological change, a widening gap between rich and poor people, ongoing bio security fragility, and continued bias of livestock development focus on producer issues.

Box 4: ICT and development

In 2005, Larry Page, co-founder of Google, visited Ethiopia, Kenya and Tanzania. As an engineer, he recognized the infrastructural shortcomings; as a human, he saw the poverty and the risk of conflict, but also a critical role for ICT in shaping change for the better, particularly in remote areas populated by the rural poor.

In a meeting called by ILRI and FAO in 2006, the seed planted by the Google visit was fertilized and developed into concrete ideas. Key among the issues were increasingly scarce resources and greater conflict in managing “the commons” the water supplies, grazing areas, and forests that had traditionally been viewed as village or tribal property as distinguished from assets (e.g. livestock) owned by individuals. Exacerbated by climate change (rainfall shifts, prolonged droughts) and population pressures, the conflicts were nearing the boiling point with risk of bloodshed. Researchers and government representatives helped bring about dialogues facilitated by an international NGO that assisted the CPPPs in preparing a proposal for ICT solutions to “manage the commons” better, including sustainable resource conservation and utilization, coupled with delivering market information and government and health services to rural populations.

First, with the assistance of an NGO, communities in the CPPP jointly agreed on a resource utilization plan (including water use, grazing land use, etc) and won buy-in by the national government on it. The national government coincidentally was thinking of offering e-gov services by internet, enabling citizens even in remote areas to access forms and make applications by email (e.g., registering births, requesting building permits, paying water rights fees, updating livestock population data, etc).

Building on a cheap microwave communications technology requiring a capital investment of \$300, a pilot was run with 10 villages, enabling them to access free internet services, using solar power for the installation. Village youths were trained in ICT, and soon assisted other villagers to become computer-literate. The villages collectively requested assistance to design and build a larger “real-time” geographic information system (GIS) package that drew on satellite observation, electronic livestock tags, and motion detection devices located at springs and boreholes. Together these enabled village elders to monitor and enforce proper observation of the resource utilization plan. The international NGO, drawing on its corporate contacts, also facilitated for a bank to donate ATM technology located at the spring, so villages could access 40 liters of free water per villager daily, with a slight charge for additional usage paid by those families having larger herds (charged at a price that tracked livestock sales prices). Proceeds were used to protect watershed catchments’ areas, maintain pipes, etc.

Benefits that emerged included:

- effective sustainable use and preservation of resources, with transparency on individual use of the common goods
- reduction in cattle theft due to electronic tagging/tracking
- more complete and timely collection of taxes
- a pro-active ability for government to (a) advise remote villagers of policy matters affecting them; and (b) enable government to hold “electronic town meetings” that allowed villagers to participate in hearings prior to new decisions influencing their future (e.g. road building proposals, phyto-sanitary regulatory changes)
- increased income for farmers due to ability to observe electronic livestock auctions elsewhere that helped redefine market prices in their areas
- growing village income as it “rented out” wireless access to passing safari tourists
- educational tools coming over the internet to villagers, including skills-based training packages on entrepreneurship, livestock husbandry, and many other topics

The capital cost of the above in 2006 was formidable and required donor assistance, but as similar initiatives were rolled out over time, technology costs fell considerably. Late joiners were pleased to find that the financial cost of the system could be born with little subsidy and paid for over time through livestock sales. Critically, each village retained ownership of the GIS and resource utilization tools and in monthly meetings of elders the issue of resource utilization of the common goods (water, land, forest, etc) was discussed. Minutes were shared with the local MP and relevant government officials, and in the interest of a balanced, well-functioning society, a pact emerged that enabled villagers and government to jointly buy into any new initiatives. Thus, through rural use of ICT, conflict was avoided, local democracy was reinforced, sustainable resource utilization was achieved, new skills were developed, and additional incomes won.

The East Africa Strategic Knowledge Management Support initiative captured the lessons of this successful ICT experiment in Tanzania and shared this information across its networks in Africa. With the ongoing reduction in ICT costs, this East African experiment spurred many more such innovative ICT initiatives on managing the commons all over Africa.

Climate change

By the turn of the twenty-first century, the impact of global climate change (GCC), especially extreme variability, was increasing so much that land-based livestock production was destabilized and unpredictable. GCC was also at the root of frequent natural disasters and new livestock diseases that led to loss of livestock, especially cattle. Local communities were trying to adapt by adopting new livestock systems and shifting from large animals (cattle) to small stock (goats). Increasing uncertainties resulting from GCC were leading to a breakdown in traditional knowledge systems and the development of new risk management practices. Rising sea levels threatened emerging mega-cities in the developing world and led to new livestock supply chain patterns and migration from rural areas. GCC was also increasing human and livestock disease threats as well as the prevalence of invasive species affecting rangelands.

2016-2025

Changing economic order

Standards for exporting livestock products were changing rapidly and several exporting countries in Asia, Latin America, and Africa were struggling to comply and adapt to changing standards regimes. Poor livestock keepers in these countries were particularly disadvantaged because they did not have the resources, information, or political influence to participate in lucrative export markets. It was widely perceived that the strict sanitary and phyto-sanitary standards on livestock products were, in reality, non-tariff barriers intentionally created to shut out poor countries and poor people in these countries from opportunities created by a rapidly growing global livestock sector. Consequently, some developing countries completely ignored these global standards, while others used the global standards as guidelines, but adapted them to suit their purposes. From developing country perspectives, scientific evidence did not seem to play an important role in support of standards setting and international conventions, and the private sector was beginning to realize that a lack of attention to these issues could check its advance in the rapidly-growing developing country markets, particularly in Asia where the demand for meat and milk was in the process of doubling between 2005 and 2020.

Co-evolution of institutions

By 2020, new organizational forms of production created a cluster of small and large producers within villages and local communities specializing in livestock activities. These new organizational forms, backed by innovative instruments to support these institutional arrangements led to higher livestock productivity and lower transaction costs, resulting in significant efficiency gains for local communities. Private producer and trader associations were strengthened and became the dominant governing institutions because of better educated leaders and populace. These new organizational forms took better advantage of new technologies, including the Internet and related ICT, to reduce coordination externalities. New genetic technologies and biotechnology were no longer “new” and were widely applied in core production to reduce health risks, ensure safety, and raise standards of livestock products. During this period there was a flux of experimentation and lessons learnt with these new organizational forms.

Dynamics of livestock production and trade

By 2020, several African countries had signed regional trade agreements with China, India and other rapidly-developing countries in Asia on standards (non-tariff barriers) and tariffs. These agreements led to increased stability in regional trade, increasing trade in livestock products and allowing countries with natural endowments for large-scale production to capture an increased share of the growing Asian and Middle Eastern market. There were substantial increases in regional livestock trade but growth remained limited because countries could not fully exploit livestock trade opportunities in the poorly coordinated global market. Improvements in African production capabilities and investments in ICT led to increased sourcing of high quality, traceable, animal welfare sensitive meat products from Africa. The key decision was the buy-in of global meat processors and retailers to commit to promoting African development. In consequence, African meat production shifted to become smaller scale, more sophisticated, and more information-based.

Advances in disease control technology and monitoring ensured that by 2020 Latin American producers had displaced European livestock producers and exporters. But growth in regional integration was uneven and fragmentary. There were few regional or bi-lateral trade agreements because of deep divisions in economic, investment, and trade policy in the region. The southern cone livestock exporting countries in Latin America such as Brazil and Chile reached out to new partners and increased livestock market shares in North American and European markets. Other countries lagged behind and were shut out of lucrative regional livestock markets. Some of the Andean producers could not even compete in their domestic markets which were now dominated by more competitive regional producers. Large numbers of small producers abandoned the livestock industry and migrated to urban areas where they joined the teeming numbers of shanty town poor.

Livestock disease pandemic

By 2020 the threat of a livestock disease pandemic stalling growth was less of a concern in some major livestock producing and consuming countries in the developing world. These countries, most of them in the fast growing economies, had learnt from the experiences of devastating livestock diseases such as SARS and avian flu and quickly put in place disease surveillance and control mechanisms that allowed authorities to contain their spread. The most successful of these efforts were supported by developments in bio-technology and the establishment of several animal health platforms that facilitated timely roll out of a wide range of improved livestock diagnostics and vaccines in the developing world.

Natural resource management

As the importance of innovative management approaches became more widely recognized, scientists and development workers organized study tours to different communities in several countries as well as between countries to help communities learn from each other about what innovations worked, what did not work, and why. In many cases, communities successfully adapted what they learnt to fit their circumstances. Local governments supported by development workers provided many opportunities for communities to talk about their problems and how they solved them. Some governments and NGOs provided training and technical support to build local capacity that promoted and supported rural organizations that empowered local communities. These allowed those countries to respond flexibly and effectively to external changes and threats. However, other governments saw rural organizations as mechanisms for political control, and did not encourage learning and adaptive management. Hence the livelihood of livestock farmers took a downward spiral into deeper poverty with significant negative consequences for management of the natural resource base. Healthy communities showed the way to sane water resources management, with local leaders finding ways to share out and protect the scarce resources. Learning on managing water for livestock use empowered the communities to solve other livestock-natural resource management issues in their communities. However, the focus on national and regional problems with local significance led to frustration as the global issue of climate change minimised progress by increasing the severity of natural resource constraints, thereby increasing competition for such natural resources as water, land and energy which, in turn, resulted in stagnation of growth in livestock production.

Science & technology

The vacuum in the organization and management of S&T in many developing countries opened the door for multi-national companies to move in and fill profitable commercial niches with very little regard for how intellectual property of local resources and indigenous knowledge was managed. By 2015, S&T was effectively controlled by the private sector in these countries. This private sector dominance of S&T had been strengthened by a series of natural disasters, many associated with climate change, which the emerging, immature national and regional S&T systems were not able to deal with. In response, after 2015, developing countries actively decided to take ownership of their resources, particularly animal genetic resources. This led to African countries becoming cut off from the mainstream of S&T, so several responded by focusing on the development of their own indigenous knowledge. Indeed, this was the spur for Africa to develop its own social, political and scientific structures. This involved substantial regional government inputs to education, and reliance on local and regional trade. Eventually, after much trial and error and inevitable problems, low-but-adequate-

input agriculture emerged which was dependent on a lot of indigenous knowledge, the natural heterogeneity of systems, increasingly precious biodiversity, and local adaptations of pre-2015 northern technology. In terms of global institutions, by 2020 FAO and the CGIAR had become irrelevant to the developing world and in their place regional institutions and structures emerged with little interest in the global picture.

Climate change

In 2020 it was recognized that due to a combination of droughts and floods there was a high probability that large areas of the developing world would not be able to feed themselves and that adaptation and management strategies by local communities would not be adequate to prevent widespread starvation. Consequently, there was great political instability within countries throughout the developing world. Only after 2020 did GCC rank highly on the national and regional political agendas, albeit in a poorly coordinated way, but leading to a widely shared emphasis on general “sustainability”. One key measure was the institution of the ideal “2 km rule” -- the idea that food should move no more than 2 km between production and consumption. Although developing country livestock production suffered considerably between 2010 and 2020, the new economic and environmental order which emphasized local production resulted in enhanced investment and subsequent growth in livestock production.

2026-2030

Co-evolution of institutions

By 2030, many societies had consolidated the ideas of livestock production within villages and local communities and they became the dominant organizational forms in livestock value chains in the developing world. In each region, developing countries were organizing themselves to focus on livestock priorities in the region, focusing particularly on animal disease control due to the potential for trans-boundary spreading of disease risks. Other issues that were addressed included the livestock genetic pool, vaccine development, veterinary capacity, and feed resources. Regional structures were established where industry and governments met to address common livestock issues.

Dynamics of livestock production and trade

Since 2015, there have been some surprising success stories from unexpected quarters of the developing world, often involving regional clusters. In every case, livestock is making important contributions to alleviating poverty in these fast-growing developing countries where increasing economic expansion has created a growing middle class. In these societies appropriate policy reforms and targeted interventions ensure that poor people capture the benefits from most of the increase in production and consumer demand for livestock products. Livestock management practices and local management of land and water resources are more sustainable. ICTs are routinely used to effectively manage livestock and resource utilization of common goods such as pastures, water, and land. These communities, including smallholder livestock keepers and other poor people dependent on livestock are not only much better off than they used to be 25 years ago, but have become active consumers and producers of their own locally based products and services.

By contrast, in many other developing countries, widening income and regional disparities have led to increasing rates of inequality even as GDP has grown. The urban areas (the focus of most political and economic activity) mirror those of Brazil and South Africa in 2005, where affluence and privilege (epitomised by sumptuous mansions in fortified enclaves) sit shoulder to shoulder with extreme poverty and deprivation in over-crowded shanty towns. Rates of rural exodus, particularly of able-bodied men and young people, are the highest that have been recorded for the past 30 years. Rural populations consist overwhelmingly of women and children, with few productive assets and limited access to information or ICTs. Common property, on which livestock keeping depends, is degrading rapidly and the traditional means for coping cannot deal with new phenomena such as climate change and more varied and sophisticated urban demands for agricultural products. The quality of life for significant proportions of the population both in rural areas and the urban slums is in a downward

spiral. In the rural areas, the potential for conflict over access to land and water resources for livestock use is high.

Climate change

By 2030 it had already become clear that the early twenty-first century predictions of the extent of GCC and the resulting weather variability had been greatly underestimated. New models were predicting 10-12 degree temperature increases globally to 2100, with relentlessly rising sea levels kicking in from 2060 onwards which would radically alter all low-lying coastlines, and overwhelm existing sea defences. In developing countries, the impacts on smallholders were already extremely serious by 2020, but the fragmented international community was proving ever more impotent and irrelevant. In the 2020s, Africa was an increasingly large importer of staple food for its still-burgeoning populations, and the problems of the control of S&T were meaning that developing countries were finding it hard to keep up. By 2030 it was clear that massive investments in education and S&T were still needed for Africa if unprecedented levels of death and chaos were to be avoided. The fragmented international community was highly unlikely to fund the investments needed. The major sacrifices being called for in the North, with public opinion permanently divided as to whether these can or should be made, cannot be counted on. More than ever before, Africa's fate is in its own innovative but insecure hands!

ADAPTIVE MOSAIC – Timeline

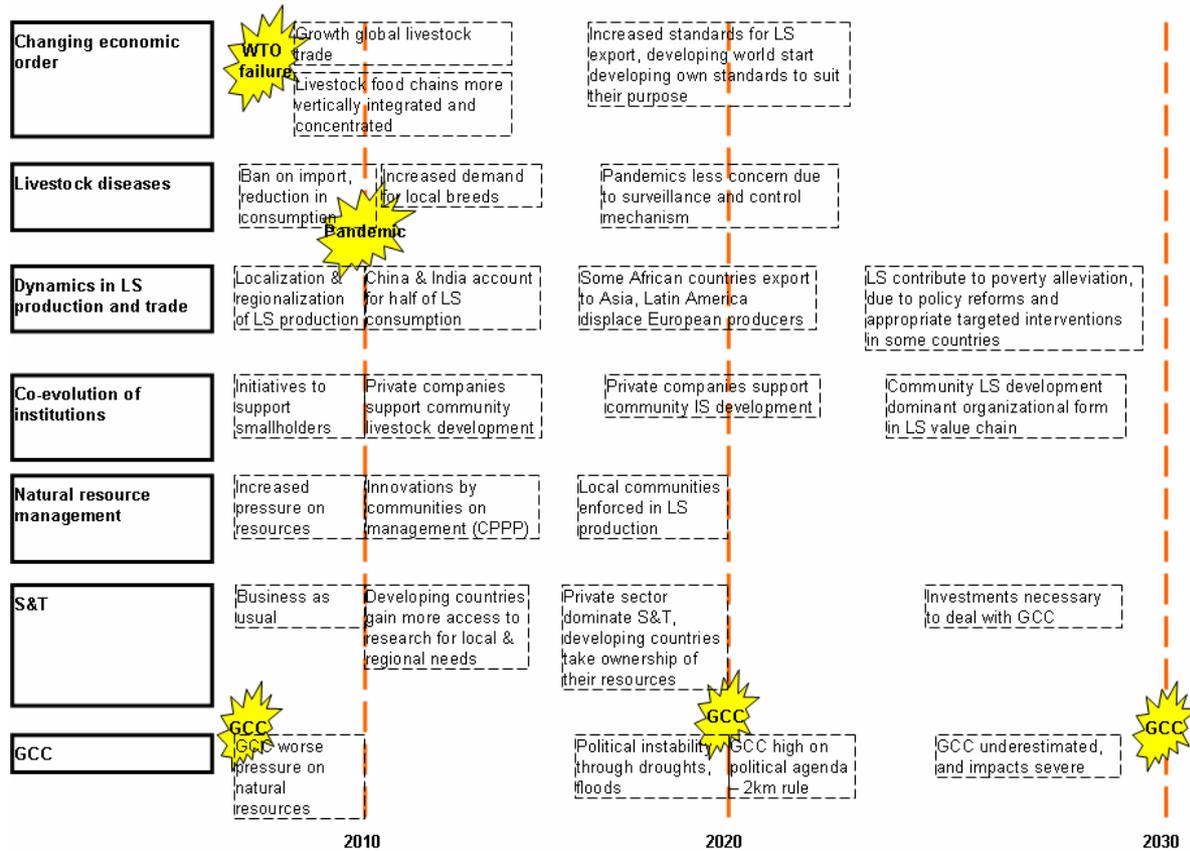


Figure 4: Timeline for the scenario Adapting Mosaic

4.4 Technogarden

Introduction

The livestock sector has changed dramatically over the past 25 years since the international agricultural assessments at the start of the century that planted the seeds that have grown into collective intelligence for improving animal products in what used to be called the developing world. Today there is a rich array of safe and nutritious animal products feeding the 8 billion people around the world. International systems and innovative local applications made the lives of those working in the livestock sector an appealing alternative to urban congestion. There were many causes of these improvements, but the dramatic improvements to rural education have to be a key one.

2006-2015

Economic order, social & industrial organization

(Missing from the workshop; added mostly from Chapter 8, MA)

At the start of the period, the issues of poverty, inequality and unfair global markets, together with environmental degradation, were addressed by a broad coalition of neo-liberals, development advocates and environmentalists, who organised against agribusiness to stimulate a global transformation of agriculture. Although small changes had begun earlier, by 2015 agriculture in substantial parts of the developed world was aimed at balancing the production of food with the production of other ecosystem services. Environmental problems were starting to be addressed through global management and cooperation. Regional and global agreements were reached on air and water quality and biodiversity loss, through sustainable management of forests, coral reefs, water and land, that would eventually prove to be quite effective. There was significant trade liberalization, and large markets started to emerge for environmental services.

Dynamics of livestock production and trade

In the last quarter of the twentieth century the growth of the livestock sector worldwide was driven by the rapid expansion of industrialised production systems of meat (mainly chicken and pork), eggs, and some milk. In the 1990s they expanded rapidly in developing countries with large concentrations of production in a few large countries, mostly in East Asia and Latin America, such that between 1967/69 and 1997/98, China and Brazil accounted for two thirds of the increase in livestock production in developing countries. Thailand was another major player. By 2006 large-scale industrialised livestock systems accounted for approximately three-quarters of the supply of poultry, 40 percent of pork, and over two-thirds of all eggs worldwide. They also formed the largest share of the rising volume of international trade in livestock products, bringing cheap meat and eggs to many urban consumers in the industrial and developing economies of the North and South. These trends continued during this time.

Driving these changes were several factors: an increased flow of foreign direct investment to developing countries, the growing importance of supermarkets in the retail food chain, declining real prices for feed grains, and technological innovation in non-ruminant production. Enabling policies and institutions played a key role in the major adopters (Brazil, China and Thailand). These industrialized systems were invariably de-linked from the natural resource base where the feeds were produced. As a result, the management of the large quantities of livestock excreta and food processing waste imposed a large burden on the environment, the costs of which were largely borne by the public.

Livelihoods and poverty

As part of their pro-poor development strategies, countries encouraged the expansion of smallholder dairy. New institutional arrangements between private sector milk processors and smallholder dairy farmer organizations flourished, which stimulated production from an average of 4 litres per household per day to 25 in a number of highland and sub-humid areas in Africa and South Asia.

Livestock disease pandemics

Despite the lower prices and convenience of the products of the industrialized livestock systems, concerns over animal welfare and the environmental and zoonotic disease threats from these “animal

factories” stimulated much public debate, led by vociferous special interest groups. Their voice was dramatically strengthened when in 2005 and 2006 outbreaks of avian flu spread from East and South-East Asia into Europe and Africa, which led to the pandemic of human influenza. Responses from the organisations responsible for human and animal health were weak, disjointed and delayed, provoking near-panic amongst many urban communities in the North and in the more industrialised countries of the South. The panic threatened the power bases of politicians and the tenure of bureaucrats, both local and international. Energised by these threats, leaders convened regional and global consultations and developed coordinated action plans to stamp out the disease in poultry and safeguard the public through vaccination campaigns. The plans attracted massive government and multi-national company funding which led to a marked reduction in avian flu outbreaks and increasing public confidence.

The UN Livestock Convention Protocol on Surveillance and Enforcement restored international confidence in animal products that include medicine and improved nutrition, as well as more conventional forms of meat, milk, and eggs. Nanotech biochip sensors mandated by the protocol are now placed in all shipping containers that keep the FAO databank up to date on the movement of all animal products and their condition. Violations of food standards are reported in real-time to WTO (OIE) as well as FAO and WHO. Counter-bioterrorism units cooperated with the implementation of the protocol to prevent the bioterrorist attacks that nearly stopped international trade in animal products by in 2012.

In 2012 two concurrent events inflamed public hysteria: first, fermentation by mutant bacteria in the reservoirs of a livestock excreta treatment plant in western Europe released poisonous gases killing 350,000 people; second, a viral disease in pigs in SE Asia infected 55,000 people in one day, 230,000 the next and 455,000 on the third day. Emergency embargos on human and livestock movements were imposed in SE, S and E Asia to control the “pig” virus and the coordinated action plans hatched for avian flu were resurrected. In Europe the gas threat led to the immediate suspension of livestock production in the affected area and the planned downsizing in neighbouring countries. Stimulated by these massive threats to an increasingly urbanised population in both the North and the South, WHO and OIE and their environmental counterparts responded to UN instructions by merging their efforts to standardise regulations and devise appropriate reward mechanisms for the control of industrialised livestock production and its monitoring for zoonotic disease and environmental threats. Measures included each site of industrialised production being bounded by an isolation bio-security zone and having an enclosed system of waste management. National, sub-regional, and regional programmes of capacity-building and infra-structural strengthening received massive investments from the new Global Fund for the Control of Zoonoses and strict accountability procedures ensured adequate operational funding and implementation.

Science & technology

The intensification of animal production systems broke linkages between where feed is grown and where animals are grown. This led to large concentrations of waste products in small areas including those that locally pollute the air, soils and water. In those countries with environmental regulations there was intensive research and development (R&D) to recover these wastes leading to more eco-friendly production systems. At the same time there were pressures on local grain producers that exported feed and hence virtual water and nitrogen to include costs of polluting landscapes via nitrate and pesticide runoff in the production costs. Today there are better biological systems to trap nitrate runoff before it enters streams and groundwater sources, but previous problems with excess nutrients in waters in high-population density areas of South Asia and Africa led to regulations on the size of manure handling in large-scale dairy.

2016-2025

Social and industrial organization

By this time, the underlying belief, which is central to the Technogarden scenario, that "ecological engineering was going to be fairly successful and produce tolerably few major unexpected breakdowns of ecosystem services" (MA Chapter 8), had resulted in two organizing principles: community, which

might mean village or geographic clusters for production, and knowledge networking, which speaks to sharing of information among individuals and actors within and outside communities. Clustering of production and services was bringing about “collective efficiency”, a pooling together of knowledge and skills and a market for goods, services and skills. It also helped to reduce transaction cost. The sense of community was starting to create a new form of institution that would foster greater responsibility and ownership of what in the past had belonged to someone else (often government). Coordination failure was minimized and information was relatively freely shared as a result.

In many parts of the world, the “village factory” was becoming a key locus of production and services, and there was a regeneration of local economies. Producers were not acting alone but in a network with others, and communities/clusters were inter-connected as a result of high-quality telecommunications and good rural road networks. Agglomerations of small producers acting in concert were resembling the big corporations not vertically but horizontally integrated. However, this was achieved at great costs in time and resources. New institutional arrangements had to be put in place to reward collaboration and punish deviant behaviour. Property right laws were enforced to encourage creativity on the part of entrepreneurs backed by global standards. Risks became increasingly socialized through shared facilities and subsidies for inventive actions. For instance, engineers and scientists from contiguous technical schools and universities started to be rewarded with points that would count towards promotion, as well as given financial incentives for contributing time to solving technical problems in enterprises. The New Community Innovation Law was designed to facilitate collaboration and focus of scientific and technical research on solving local disease, environmental and food problems. Some young engineers developed a new environmentally-friendly waste disposal system that turned waste to fuel; this was widely adopted in several communities through government subsidy.

Private associations have also become very active in providing services to small enterprises and farms. A new form of organization was replacing the cooperatives and commodity boards. These organizations built testing and quality laboratories for small and medium producers. They gave demonstration on packaging. There was closer collaboration with central and local government to support Village Factories by building Business Support Services Centres (BSSC) to provide information and training. Training centres on a myriad of subjects were operating and small farmers could often obtain services at little cost.

Dynamics of livestock production and trade

Working in parallel with the control efforts for disease control were the impacts on the competitiveness of industrialised livestock systems of higher grain prices resulting from cropping systems governed by sustainability criteria, increasing demand for “natural/free range” meat and eggs, and the technological advances in these “natural” systems. The demand for organically-grown and free-range animal products continues to grow to this day. Some regions are able to support these practices because of the abundance of rangelands that are not adversely affected either by climate change or invasive species and where these lands will be of highest value for animal products. The reclaimed coastal lands from seawater agriculture are also providing new spaces for free-range animals today. But even back in 2020 the changes had resulted in a 30% decrease in livestock production in industrialised systems.

Livestock disease pandemics

By 2015 the benefits of coordinated efforts in capacity-building and infra-structural strengthening were restoring confidence in the public health authorities, helped by the global ICT monitoring and reporting systems through which the public could access daily information on the status of human and animal health at all sites of industrialised production.

It was uncontrolled expansion of informal pig units that created a crisis that generated the political will to create better international systems. Units from 5 to 40 sows usually escaped regulatory notice until a new viral disease of pigs spread rapidly throughout East and South-East Asia and jumped to humans with several hundred fatalities. All non-industrial pig operations were closed in China, Malaysia, Thailand and Vietnam. This stopped the incidence of the disease, except for an occasional flare up to this day. Initially, village pigs in Laos and Cambodia were thought to be the reservoirs but eventually it

was shown that rats and other small rodents asymptotically carried and spread the virus. Over time the virus decreased in pathogenicity and caused only occasional disease in pigs and humans.

After several years, more regulated piggeries, both industrial and medium-scale, were allowed that could meet regulations for rodent control. Village pigs still persisted in more marginal areas. Municipal authorities also more closely monitored urban and peri-urban livestock facilities of other types enforcing stricter and stricter sanitary regulations. In more densely populated cities, this tended to drive livestock production to peri-urban areas.

Global climate change

(Missing from the workshop; added mostly from Chapter 8, MA)

During this period there was a global post-Kyoto agreement on climate change, which resulted in a lowering of future projections of temperature changes. Removal of subsidies for fossil fuels, nuclear energy, and large hydro projects stimulated the development of a variety of alternative energy sources (including solar power), and a wide range of regional and global strategies were implemented to address the root causes of climate change.

Science & technology

The applications of cognitive science to the design of INEDSAT's Tele-educational systems – that connected nearly all the schools in the poorer regions of the world by 2015 – revolutionized the educational capacity of these regions. Most Ministries of Education have now adopted increasing IQ or brain functioning as a national goal. Competition among ICT companies to get the brain-ware market became intense. Variations of individual collective intelligence software have become common place and accessible via nanotech transceivers in many objects from clothing to bicycles. Voice recognition and synthesis allows children to grow up with brain-ware as easily as they grow up with their human families. With the continuation of Moore's Law, the costs have become so low that transceiver systems and access has now become a right of citizenship. Marketing interests pay for the equipment costs for individual access. Just as the original Internet made much of the world's knowledge freely available, so too has Internet4 made virtual reality learning environments free as well.

A wide range of technological improvements had impacts on agricultural productivity. Irrigation systems became more efficient, precision fertilization and accounting systems become more widespread, and water-use and nitrogen-use efficiency in feed crops was continually being improved through genetic manipulation. Genetic manipulation was also reducing the birth-to-harvest period for many domesticated livestock species. Rapid progress was made in environmentally benign pest control through the use of pest-resistant genes and natural pest predators. These and many other improvements enabled increased yield on agricultural lands with only limited environmental impacts, and saved substantial areas of wildland from potential development.

At the same time, to counter the growing dissatisfaction in certain segments of society with factory-produced animal products, there were increasing pressures to increase, and demonstrate animal welfare in industrial systems. This prompted a substantial investment in animal welfare and social science research, to find ways to minimise the adverse human social impacts of confined animal production systems.

2026-2030

Dynamics of livestock production and trade

Increasing food prices helped the inland farms get easier access to key inputs such as artificial insemination, appropriate feeds and preventive veterinary and management advice. Meat production and consumption over the past 25 years was driven by: 1) the increasing concern about the ecological and animal welfare impact of intensive livestock farming in developed countries; and 2) rising incomes in Asia leading to increased demand for low cost meat. Successful smallholder dairy farmers became slightly larger (from an average of 1-2 ha up to 5 ha) and more specialized – focusing on dairy production, fodder production and some associated high-value agriculture (fruit trees). The system has

now become so successful that 90% of milk is produced by smallholders and over 90% of smallholders participate in organized schemes. Other smallholders who specialized in high-value crops have also become more successful with similar institutional arrangements with the private sector and an improvement in new irrigation methods that are much more water efficient. As with dairy, farm sizes increased slightly as more successful farmers expanded and the less successful ones found employment locally or in cities. Medium-scale ranches have increased since large ranches were no longer politically acceptable and very small ones were no longer economically feasible.

Even with all these improvements it was necessary to augment meat supply with animal protein from cloning muscle cells stimulated from pig, goat, and cow stem cells taken from blood from the umbilical chord. When it was forecast that China's per capita meat consumption would equal that of the United States by 2030, the enormity of the future meat requirements attracted entrepreneurs to buy licenses for the processes from the Netherlands to produce meat in larger quantities. In many circumstances, this has eliminated the need to grow the entire animal. The initial research in The Netherlands created a systematic approach to both local and mass production of meat.

Other forms of biomimicry, which applies lessons from how nature does things to manufacturing and agriculture, have been used in combination with innovations in nanotechnology. Healthier agricultural practices and pharmaceuticals have been developed both with reference to indigenous knowledge systems, and by observing what plants animals eat to stay healthy. This concept helped focus research and development that found many applications in the livestock industry.

Although the Livestock State of the Future Index (L-SOFI) did not begin to show sustained improvement until 2023, it has been showing consistent improvement for the last seven years. L-SOFI challenged the livestock sector to answer what it would mean that the sector is better or worse in ten years in quantifiable terms. These indicators are now annually forecasted and aggregated into a single number to show the ten-year outlook for livestock. Although many argued that the ten-year future could not be condensed to a single number for the sector, it did and still does today force one to be clear about what is strategic and synergistic to improve the sector over a ten year period. L-SOFI is used by FAO, ILRI, and others to prioritize investments to help the sector as a whole by identifying points of leverage for policy. It was especially useful for governments to prioritize the use of carbon trading income.

Livelihoods and poverty

The carbon trading system initiated 25 years ago now provides a cash flow to rural communities undreamed of in the past. Governments have relied on international organisations for advice about the most cost-effective uses for this money to help improve rural income and livestock management. This helped improve all dimensions of livestock production from the sustainable production of feed stocks and their formulations, greater efficiencies in feed conversion, as well as improvements and transparency in animal care and the social welfare of workers in industrialized production leading to greater economic margins in production and social acceptance of factory-produced livestock products.

The global indicators were starting to show that while the number of people living in absolute poverty was declining globally, there were still enormous differences in income between richer and poorer countries as well as within nations. This continuing inequality was blamed for social tension, crime and sometimes terrorism.

Livestock disease pandemics

Despite occasional outbreaks between 2015 and 2025 of new zoonotic diseases and some low-level environmental disasters, the continuing pro-active approach to environmental management and the effective international cooperation programmes for public health resulted in the general public accepting that health and environmental risks from industrialised livestock systems were manageable. With the success of the UN Livestock Convention Protocol on Surveillance and Enforcement, national and corporate R&D budgets have grown dramatically making animal products the success we enjoy today.

Science & Technology

The rural-urban educational polarization is nearly gone and the economic polarization has also been greatly reduced. Cyberspace has become a new medium for civilization. The life styles of small holder farmers of the last generation has now been replaced by the cyber-augmented multi-income life-style that makes rural life of today so attractive that the urbanization migration trends have slowed in many parts of the world. People live in both the geographic communities as well as knowledge and interest communities via Internet. The old threat to the livestock sector of younger people leaving the farm for the urban ICT business world has been reduced. Living among animals, natural environments, and breathing cleaner air - while having the advantages of micro-miniaturized high-tech and its tele-realities - has become a successful alternative to the urban crowding in the rest of the world. (See Box 5 on the "coastal green rush").

2030 and beyond

Science & Technology

Base load electricity is now augmented by INSOLSAT's orbital solar satellites that microwave energy to receivers around the world. Rural receivers that are connected to national electric grids have ended the continual urban brownout problems during the 2020s. Large rural areas such as in Sudan now have wireless energy transmission from line-of-sight receivers as well as satellite relays to electrify many remote settlements. Within the next ten years the INSOLSAT system of 120 solar satellites should be complete, guaranteeing abundant electricity for all – including rapidly-growing electricity demand for electric cars.

Global climate change

Despite many technological innovations such as use of electric cars, biofuels, seawater agriculture, stem-cell induced meat, and overall efficiencies, the continued emissions of greenhouse gases continued to change the climate. Global warming increased disease threats to animals and humans and those arising from the prevalence of invasive species affecting rangelands. Sea levels rose 20 cm by 2030, and future rise will threaten emerging low-lying mega cities. This caused new supply chain patterns and further population migration. The sea levels are expected to continue to rise by a further 15 cm by 2050. Physiological effects of increasing CO₂ concentrations have reduced the nutritional efficiency of certain feedstocks as well. These changes also made the reliability of inputs of animal production uncertain. These uncertainties broke down traditional knowledge, which accelerated the development of more risk-avoidance production systems including industrialized methods and away from marginal landscape extensive systems. Increasing frequency and intensity of storms and flooding have damaged low lying and highly productive areas and calls for new kinds of disaster relief systems for those dependent on local agricultural systems including livestock production.

Animal systems were affected by greater heat stress on animals in certain dryland regions, reducing milk production. Pests, parasites and pathogens increased in areas where climate change was faster and adaptation of local management strategies were not able to keep pace. Some who gave up went to the cities while others homesteaded in the new coastal green areas. Fortunately, seawater agriculture was not damaged by this, but those along coasts that kept to fresh-water-based practices suffered from sea water intrusion into fresh water aquifers.

Box 5: The Coastal Green Rush

The tenth anniversary of the Seawater Agricultural TransInstitution (SATI) celebrated the achievement of its 10-10 goal to make 10% of coastal deserts green within 10 years. One wonders how better the world would have been for small holders and rural people had the Coalition been created before 2020, since most of the science was known before the year 2000. For example, it was known that of the 10,000 natural halophyte plants more than 250 were potential staple crops for humans and animal feed and that seawater had a wide variety of important minerals and about 80% of the nutrients required for agriculture (nitrogen, phosphorus, and iron did need to be added). The increasing impact of climate change, increasing biofuels and food demand finally brought this option to world attention.

The vast desert coastlines of Somalia, China, India, and Namibia have become salty Gardens of Eden growing salt-tolerant plants on beaches for human as well as livestock feeding, biofuels, fertilizer, raising water tables, and absorbing CO₂. The greening of coastal deserts is beginning to “reclaim” and desalinate land and attract new settlements for small holders as well as corporate agricultural and energy companies.

But getting the decision to begin the massive conversion of coastal deserts required that better institutional arrangements were necessary among governments, universities, corporations, NGOs, and international organizations; hence the birth of the “TransInstitution.” Even private contributors were welcomed in the TransInstitution to help jump-start the funding using the example of the old big three: Soros, Turner, and Gates. As progress was clear by 2025, the “Coastal Green Rush” began and corporate investment poured in. Small holders have begun migrating from inland in large numbers to these areas of vast potential. With genetic modifications even tomatoes and rice are grown in salty conditions. The abundant tropical sun also produces electricity from strips of nano-photovoltaics which are used to produce hydrogen directly via electrolysis using saline or salt water. Direct photo-catalytic electrolysis is also being used in some deserts for H₂ production. With flex fuel standards for cars and oil prices ranging between US\$80-120 per barrel, there is an endless demand for biofuels from these coastal areas.

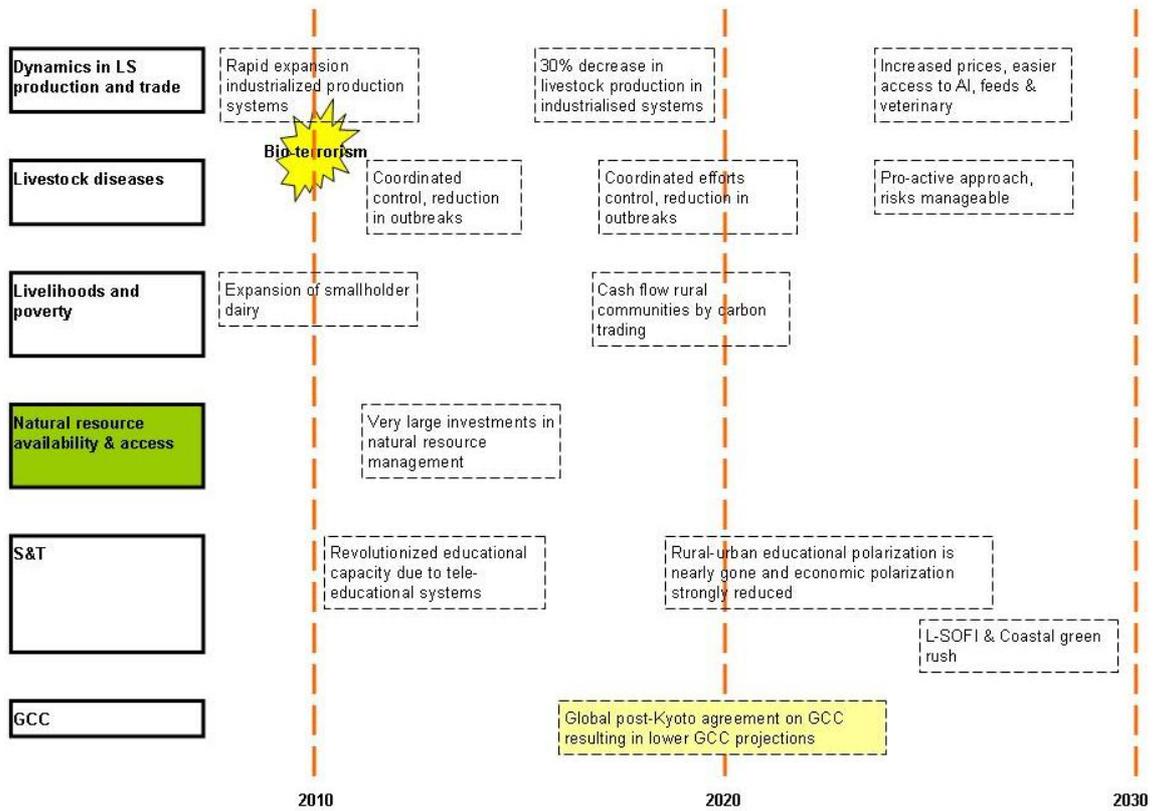


Figure 5: Timeline for the scenario Technogarden

5 Cross-Cutting Issues and Next Steps

A summary of the key issues addressed in the workshop scenarios is shown in Table 2. Several points can perhaps be made. One relates to the way markets become organised in particular ways through time, and the resulting risks that smallholders become excluded from these markets. In Global Orchestration, for example, livestock farming is seen as shifting from a multipurpose smallholder activity to a single-purpose, vertically-coordinated industry, but substantial problems are envisaged in many of the poorer countries, with smallholders being unable to participate in global markets. For different reasons, poor livestock keepers in Order from Strength and Adapting Mosaic are also envisaged to be largely excluded from local and regional markets.

A second point is the role of livestock disease and food safety crises as powerful drivers of change - this is perhaps not surprising, in view of recent developments in relation to avian flu. In Global Orchestration, a more coordinated approach to global food safety issues occurs largely as a result of a new prion spread in milk that was found to have infected tens of thousands of people. In Order from Strength, Rinderpest returns to East Africa within a decade, and BSE and mutating FMD cause problems in several places. The threat of bioterrorism drives many countries to impose increased regulation and monitoring, but with significant impacts on freedom of movement and information. Avian flu reaches pandemic proportions in much of the developing world in Adapting Mosaic, and this contributes to the drive to restrict trade and animal movements on a global scale, with associated regional approaches to dealing with the same problems. In Technogarden, hundreds of thousands of people are affected by mutant bacteria in livestock excreta and a viral disease in pigs in South East Asia. These events drive massive global programmes of capacity building and infrastructural development, and bring about considerable changes in social values and industrial organisation.

Third, there is considerable variation between scenarios in the institutional landscape within which regulations and R&D are carried out. In Global Orchestration, multinationals overtake the power of governments in shaping the agricultural sector, and the sway of regional bodies is gradually diminished. In time, the MDGs are abandoned, and R&D is completely polarised between knowledge as a public good and its commoditisation, with predictable impacts on the poor in many developing countries. In Order from Strength also, the flow of scientific information becomes very much restricted. Adapting Mosaic sees the development of alternative government-industry models based on community public-private partnerships, which eventually become quite successful but as in other scenarios, R&D is effectively controlled by the private sector, spurring renewed focus on indigenous knowledge in developing countries. In Technogarden, communities become the key locus of production and services, and these are knowledge-networked as a result of massive investments in telecommunications, ICT and infrastructure.

A fourth point relates to natural resources and climate change. In Global Orchestration, negative environmental impacts and the problems of climate change and variability become increasingly serious, and these are dealt with as they arise, largely by the global private sector. In Order from Strength, global natural resource and climate-related issues are almost impossible to address, many developing countries see considerable environmental degradation that adversely affects millions of smallholders. In Adapting Mosaic, considerable headway is made in managing common resources through community action at local level, but global problems remain largely untreated, leaving many millions of people, particularly in Africa, highly vulnerable to global change. In Technogarden, global changes are dealt with through the application of new technology, although there are considerable impacts on population migrations and agricultural production patterns.

The tenor and end-points of the four scenarios are quite different. In the Global Orchestration scenario, the world is characterised by enormous inequality both between and within countries, with considerable levels of civil strife. The developed nations are spectacularly ill-equipped to deal with the consequences of the natural resource devastation that occurs in the late 2020s, and although poor rural communities have been largely excluded from globalisation processes of the previous 20 years, the scenario ends with a glimpse of a "return to nature" for the developed world, based in part on the

knowledge acquired over centuries of the basics of survival (food production) by smallholder farmers, particularly in Africa.

The Order from Strength scenario is also characterised by enormous inequality both between and within countries. The impossibility of global negotiation to deal with the staggering problems caused by vanishing natural resources and climate change mean that these problems continue to worsen inexorably. There are trends towards increased community action and control of natural resources in some developing countries. The picture is lightened somewhat towards 2030 by the advent of an energy revolution (viable and controllable nuclear fusion), but it is unclear what impacts this will have on many of the deep-seated problems of the day.

The tensions between richer and poorer nations are still apparent in the Adapting Mosaic scenario, although to a lesser degree than in Global Orchestration and Order from Strength. Some developed and developing countries are managing to cope well, through combinations of taking on board new technologies and trying out new institutional models of organisation, but there are many others where stagnation is occurring and poverty increasing. As in Order from Strength, global negotiation to deal with natural resource and climate change issues is largely impossible, and the prospects of Africa being able to feed its still-burgeoning population are not good -- massive investments in education and science and technology are needed, and the scenario ends with some doubt as to whether these investments will (or can) be made by the developed countries. As for Global Orchestration, there is a hint at the end of an Africa that is once more highly dependent on its smallholders for survival.

The Technogarden scenario describes a world where science and technology have had enormous impacts on many aspects of people's daily lives, including agricultural productivity. Globally, the number of poor people is declining, but there are still substantial inequalities between and within countries. Global negotiation to deal with key global problems takes place, and while degradation and climate change impacts are not avoided, they are largely dealt with via technology and migration.

As the report of the MA makes clear, all four scenarios involve trade-offs between social, environmental and political objectives; in all scenarios, food security remains out of reach for many people, and child nutrition cannot be eradicated by 2050, even though the supply of food increases under all scenarios and diets in poorer countries become more diversified. On the other hand, trade-offs between ecosystem services continue and perhaps intensify. None of the four scenarios describes the world as most of us would want to see it -- this was certainly not the point of the MA scenario analysis.

Similar trade-offs are apparent in these livestock scenarios. A world based on Order from Strength would entail misery for a large proportion of the human race, not just in developing countries. In Global Orchestration and Adapting Mosaic, the potential role of African smallholders in responding to calamity is highlighted, but the amount of human suffering in the meantime would be enormous -- and for the world in Adapting Mosaic, massive investment would be needed in education and science and technology. Of the four, the Technogarden scenario presents perhaps the rosier plausible future, although the MA report sees Technogarden as having highly negative impacts on human social relations. It is also interesting to speculate about the cost of investment in R&D and technology in the Technogarden scenario.

The scenarios contain interesting indications as to the type of research organisations that will need to exist, and the role of technology and indigenous knowledge in managing risk and natural resources. These issues are in the process of being written up in a comprehensive fashion, both at a global level and at regional level (for Central and West Asia and North Africa, East and South Asia and the Pacific, Latin America and the Caribbean, North America and Europe, and Sub-Saharan Africa) for the IAASTD, due to be published in 2007.

As noted in the introduction, the workshop that this document is reporting is just one step in a longer-term, more comprehensive process designed to encourage flexible thinking about alternative

possibilities for the future, so that decision makers can begin to come up with appropriate portfolios of activities that will help people adapt to the future. In terms of next steps, some thought could be given to harmonising the workshop livestock story-lines with the MA and IAASTD scenarios (which have been developed in much greater detail, although not with the livestock perspective found here). An advantage of doing this is that many of the scenario impacts can be quantified, using the suite of modelling tools that is currently being utilised for the IAASTD. This would be particularly useful for carrying out ex ante impact assessment and priority setting of alternative options, for example.

In addition to attempting to quantify some of the impacts of the scenarios at highly aggregated levels, there is a lot that could be done to look at possible impacts at landscape and household levels, particularly in relation to how specific farming systems might evolve in response to particular drivers of change. A recent review proposes the development of a set of integrated case studies of different production systems that could greatly expand our knowledge (Nicholson, 2006). Although the issues of land-use change, climate change and land degradation are notable exceptions, there are relatively few examples in the current literature that have a specific emphasis on prediction of future evolution of production or livelihood systems in agriculture generally or those with livestock more specifically. Development of a series of case studies would be a useful contribution to understanding the future evolution of systems with livestock, enhancing methods to evaluate systems evolution, and raising awareness of the importance of this type of work. These efforts could usefully build on the sorts of scenario analyses presented here.

Table 2: Comparison of key issues addressed in the workshop scenarios

	Global Orchestration	Order from Strength	Adapting Mosaic	Technogarden
Economic order, institutional change/ social and industrial organization	Market liberalization. Large multinationals (global value chains) dominate world trade. Subsidies for livestock products eliminated.	Decentralised and locally adapted multinationals control markets. Reduced level of international trade, domestic consumption increasingly important.	Livestock trade increasingly regulated by “free trade” rules. Multinationals important in livestock food chains as they become vertically integrated and increasingly concentrated.	Global cooperation and management of environmental problems. Significant trade liberalization and large, emergent markets for environmental services.
Livestock disease pandemics	Livestock production systems move into non-traditional production environments due to global climate change and competition for natural resources, leading to increase of severity of animal disease treats.	Treatment of global transboundary animal diseases decline due to lessen international trade. Outbreaks of diseases are local and more severe due to lack of control of infectious diseases.	Learning from experiences of devastating livestock diseases and put in place disease surveillance and control mechanisms that allowed authorities to contain their spread.	Coordinated control efforts lead to reduction of disease outbreaks. Risks become manageable due to pro-active approach.
Dynamics in livestock production and trade	Livestock markets polarized by single-purpose vertically coordinated industry, leading to ever-higher productivity, lower transaction costs and resulted in group efficiency gains, making use of new technologies.	Most countries/ regions forced to be self sufficient, due to fall international trade. Livestock industry continued to grow, due to global exchange of ideas and development of technologies and local adapted management systems.	Inward orientation of livestock production and trade, specific countries shaping economic configurations and decision making; agreements lead to increased stability and trade.	Demand for organically-grown and free-range animal products continues to grow, changes resulted in a sharp decrease in livestock production in industrialised systems.
Natural resource dynamics/ management	Negative impacts on environment growing unabated. National and local governments address problems on case-by-case basis.	Because the world is unable to negotiate solutions to disappearing natural resources and climate change, these problems worsen.	The rapid pace of dynamic changes in rural areas was putting pressure on the capacity of traditional self sustaining systems to cope. Innovative management approach.	Management of large quantities of livestock excreta and food processing waste imposed a large burden on the environment. Vast desert coastlines have become salty Gardens of Eden.
Science & technology	Contributing to polarization of livestock industry, due to centralized drive in technology focussed on trade and movement of livestock across borders (new diagnostics, vaccines, monitor and control animal diseases).	Free flow of scientific information much restricted by proprietary approach of dominant multinationals, so production of international public goods has stalled.	S&T effectively controlled by the private sector (multinationals) with little regard for how intellectual property of local resources and indigenous knowledge is managed	Intensive S&T to recover waste pollution leading to more eco-friendly production systems.
Climate change	Top-down, public-eye-catching initiatives mostly poorly designed and coordinated, resulting in little long term, sustainable impact of range of global climate change problems.	No orchestrated responses to climate change, natural resource conflicts (water, land) are common.	The impact of global climate change, especially extreme variability, increased so much that land-based livestock production was destabilized and unpredictable.	Despite technical innovations, global climate change increase disease threats to animals, reduced nutritional efficiency of feed stocks, break down traditional knowledge systems etc.

	Global Orchestration	Order from Strength	Adapting Mosaic	Technogarden
Education	-	-	Decisions by many developing countries to establish universal free education had positive spin off impact on poverty alleviation and improved livestock management.	Rural-urban educational polarization is nearly gone due to applications of cognitive science to design of Tele-educational systems – that connected nearly all schools in poorer regions.
Energy sources	Global oil security concerns led to significantly investments in many short and long terms alternative energy sources.	Known reserves of fossil fuels were rapidly depleting, and the alternative energy technologies just were not delivering.	-	Base load electricity augmented by INSOLSAT's orbital solar satellites that microwave energy to receivers around the world.
Migration/ livelihoods/ poverty	Contract farming and large scale production prevail, but also many successful examples of alternative solutions, variations on community owned “cooperative” models.	Rural poor produce own food, subject to drought, flood, contamination and livestock health. Urban poor survive on restricted and unpredictable diet, often with high health risks.	Quality of life for significant proportions of the population both in rural areas and the urban slums is in downward spiral.	Life styles of smallholders replaced by cyber-augmented multi-income life-style that makes rural life so attractive that urbanization migration trends have slowed.
Food safety	Private sector regulation led by processors and large retailers drove up not only food safety standards but also environmental and animal welfare standards, reinforced by consumer preferences.	Increased emphasis and expenditure on enhancing food security, quality and safety within national and regional boundaries, and trade in livestock products is highly regulated.	Consolidated genetic technologies and biotechnology to reduce health risks, ensure safety and raise standards of livestock products. Regional structures addressed issues like livestock genetic pool, vaccine development, veterinary capacity, and feed resources.	-

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