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NEW TRENDS AND CHALLENGES

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CHAPTER 3.1

RESOURCE OVER-EXPLOITATION AND RUNNING OUT

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SUMMARY

Food systems around the world are highly dependent on both renewable and non-renewable resources. Drivers such as population growth, urbanisation and climate change put a lot of pressure on resources that have become core issues for the future of food systems. Cropland availability is limited in most parts of the world, adding pressure for cropping intensification. Fossil energy and phosphorus shortages are expected to occur within a few decades, with particular impact in Low-Income (LI) countries where farmers are more vulnerable to volatile prices. The availability of very unevenly distributed freshwater resources shows a similar picture, with an increasing number of regions reaching alarming levels of water scarcity. Some world fish stocks have been over-exploited and are now depleted. But the situation is not without hope. While we need to intensify food systems to meet the challenge of a growing population, new ways to produce with less impact on the environment and more resilience to climate change need to be widely adopted.

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Food systems around the world are highly dependent on both renewable and non-renewable resources. Given the growing population, maintaining and displaying available and sufficient cropland, energy, phosphorus, freshwater and biological resources to provide adequate food for humanity has now become a major challenge.

Land-use and land-use changes

Land-use and land-use changes have become core issues for the future of food systems. Most of the world's soil resources are in fair to very poor condition and their condition is getting worse. In particular, 33 percent of land is already degraded due to erosion, salinisation, compaction, acidification and chemical pollution (FAO, 2015). Most lands that have been recently cleared of natural vegetation and forests to grow crops or graze livestock, suffer from increased erosion and losses of soil carbon, nutrients and soil biodiversity. Intensive non-sustainable agriculture has degraded wide areas, including the contamination of soils through excessive use of inorganic fertilisers and pesticides. In traditional agriculture, intensification can also result in soil degradation, a particularly significant threat in sub-Saharan Africa where yield gaps are high. In this region, agricultural land is especially prone to erosion and nutrient depletion: soil erosion accounts for more than 80 percent of land degradation, affecting more than 20 percent of agricultural land (FAO, 2015).

Moreover, with the exception of some parts of Africa and South America (Le Mouël, de Lattre-Gasquet and Mora, 2018), there is little opportunity for the expansion of agricultural areas. And much of the additional land available is not suitable for agriculture, with the ecological, social and economic costs of bringing it into production being very high, sometimes with acute competing claims. In addition, demand for alternative liquid fuels has driven the diversion of cropland to biofuel production, reducing cropland for food production. Biofuels produced from agricultural crops may reduce food supply and boost price volatility, increase CO_2 emissions and hold back rural development in LI countries (HLPE, 2011, 2013).

Pressure on land has numerous impacts. Understanding the impact of land-use change on both food production and climate requires new indicators and metrics (Searchinger *et al.*, 2018). Biodiversity is under particular threat, with an erosion of the ecosystem services it provides, due to land-use changes and unsustainable agricultural practices. A considerable number of species are under threat due to over-exploitation of habitats or pollution. Tropical forests are already reduced and fragmented. Marine ecosystems are threatened and freshwater biodiversity is decreasing. Agriculture, through land pressure, contributes significantly to these changes and, in return, is itself impacted. Agricultural intensification has led to a strong homogenisation of agricultural landscapes and the loss of natural and semi-natural habitats (Foley *et al.*, 2005), leading to serious biodiversity losses.

The impacts of land-use change on biodiversity and carbon sequestration are greater in LI countries and closely linked to international trade, which is the main driver. Between 2000 and 2011, the erosion of biodiversity can be linked to cattle and cereal production, while the reduction in carbon sequestration can be mainly linked to forestry and cattle. The regions experiencing the greatest biodiversity loss are Central and South America, Asia, and Africa. When looking at the relative change over this period, the impacts in Asia are striking for both biodiversity loss and carbon sequestration, and are mainly linked to oil production and the forestry sector (Marques *et al.*, 2019).

Fossil fuels

Fossil fuels are used in large quantities in food systems. The food sector (including input manufacturing, production, processing, transportation, marketing and consumption) accounts for approximately 30 percent of global energy consumption and produces more than 20 percent of global GHG emissions (FAO, 2016a). However, subsistence producers around the world have very low energy inputs, with energy usually derived from human and animal power. Industrial agriculture requires lots of energy for chemical inputs, farm machinery, heating protected crops and irrigation systems. But industrialising agricultural systems by increasing fossil fuel inputs may no longer be a feasible option. Finite supplies and increasingly difficult access to fossil fuel have already impacted fuel and food prices in most parts of the world (HLPE, 2011). Their impact will certainly increase in the coming decades.

Phosphorus

Phosphorus (P) is another critical non-renewable resource for agriculture. Currently, nearly 90 percent of extracted phosphorus is used in the global agri-food system, most of it used unsustainably as a crop fertiliser (Childers *et al.*, 2011). Inefficient phosphorus use in agri-food systems is a threat to the global aquatic environment and people's health. The Green Revolution required a large increase in the use of inorganic phosphorus. Projections show that economically viable mineral reserves will become depleted within a few decades and, as a major nutrient, there is no substitute (Cordell and Neset, 2014). Phosphorus-induced food shortages are therefore a possibility, particularly in developing countries where farmers are more vulnerable to volatile fertiliser prices. Indeed, Africa is the world's largest exporter of mineral P but, compared with Europe, P fertiliser is more expensive in sub-Saharan Africa, both in terms of its real price and as a percentage of a farm's budget. This means that P accessibility for a sub-Saharan African farmer is considerably lower than for a European farmer, even though both are using mineral P from the same source (Cordell, Dranger and White, 2009). Soils depleted in P are already responsible for lower crop yields and increased inter-annual variability in food production in sub-Saharan Africa (Vitousek *et al.*, 2009). Sustainable solutions to such future challenges exist and involve closing the loop in the human phosphorus cycle (Childers *et al.*, 2011).

Freshwater resources

Freshwater resources and irrigation are important for adapting to climate variability and moreover for climate change, as well as for increasing land productivity. More than 70 percent of all available freshwater in the world is used by agriculture (HLPE, 2015; FAO, 2018a). Although irrigated areas occupy less than 20 percent of the world's total arable area, they generate more than 40 percent of the total production value globally (HLPE, 2015; FAO, 2018a). This disproportionate contribution is attributed to greater productivity in irrigated areas as a result of higher and more stable yields and more intensive cropping, as well as to the cultivation of higher value crops compared with rainfed cultivation (FAO, 2018a).

How much cropland can be irrigated under future conditions is therefore a key question for determining food production. Only 6 percent of the cultivated area is equipped for irrigation in Africa. This figure falls to only 3.4 percent in sub-Saharan Africa, compared to 40 percent in Asia (FAO, 2016b). Ultimately, the potential for converting rainfed land to irrigated land is determined by the water resources available. However, freshwater resources are very unevenly distributed across the planet, with an increasing number of regions reaching alarming levels of water scarcity. Over-withdrawal of surface and groundwater has already led to depletion of water resources and environmental damage in some regions in India, Pakistan and China. The pressure on renewable water resources from irrigation will increase slightly, especially in countries that already suffer from water scarcity in the Near East/North Africa and South Asia (FAO, 2018a). The right incentives and technologies to use less water and increase water use efficiency (such as using drip irrigation, reusing wastewater, water harvesting and storage etc.) will be necessary (FAO, 2018b).

Fish

Fish is an important component of healthy diets throughout the world, providing 20 percent of the average per capita intake of animal protein to nearly 3.2 billion people (FAO, 2018b). As a result of demographic growth and dietary changes, global demand continues to increase, leading to a growing pressure on the resource (*cf.* Box 5). Inland fisheries also play a major role in food security and nutrition in many developing countries and their importance is probably underestimated. Inland fisheries continue to grow in several countries, especially China, India, Cambodia, Indonesia, Nigeria, Russian Federation and Mexico, but given that freshwaters are one of the ecosystems most heavily impacted by humans (pollution, habitat loss and degradation, draining of wetlands, river fragmentation and poor land management), concerns have emerged with regards to their sustainability (Funge-Smith, 2018).

Could aquaculture be a solution for reducing pressure on wild stocks? Currently, 70 percent of aquaculture production is fed using home-made or commercial feed. Although fishmeal and fish oils are still used to feed farmed fish, new technologies and progress have allowed aquaculture to become a net fish producer: for every kilogramme of wild fish consumed, 4.5 kg of fish is produced (IFFO, 2017). The challenge now is to fill the demand gap, while maintaining environmental and social impacts within boundaries that do not affect the sustainability of the system. Agroecology and exploiting the synergies between aquaculture and agriculture are promising options.

Sustainable agricultural methods and reduced dependence on fossil fuels are essential to address the food security challenge and critical for the transition to sustainable food systems based on renewable energy. Becoming 'energy-smart' along the food chain by reducing the high dependence on fossil fuels will require new policies and institutions and significant investments in new agricultural practices and clean energy technologies.

For the future, it is also important to consider the evolution of food diets. As incomes rise, one generally predicts a shift towards a higher proportion of non-staples in the diet (FAO, 2018c). At the level of food systems, this means that one can expect a disproportionate growth in the supply chains of non-staples such as fruit and vegetables, meat and fish, dairy and edible oils, thereby contributing to changes in local cropping systems. Meeting the challenge of feeding the world's population will require new agricultural pathways that combine efficient use of arable land without deforestation, restoration of soils, mindful choices between the use of agriculture for food, animal feed and energy, efficient multiple uses of water, attention to global nutrient cycles, protection of biodiversity and ecosystem services, as well as adaptation to climate change in a context of increasingly limited supplies of fossil energy and correspondingly rising energy prices. While we need to intensify our food systems to meet the challenge of a growing population with evolving diets, we must do so in a way that preserves resources and is more resilient to climate change.

BOX 5

FISH RESOURCES: IS IT TOO LATE?

FAO has been monitoring the status of the world's marine fish stocks since 1974, highlighting that the share of stocks unsustainably harvested has regularly increased, representing one-third of the total in 2015 (*cf.* Figure 16, from FAO, 2018b). The production of capture fisheries has stagnated since 1990 at around 90 million tonnes, while aquaculture production has increased from less than 10 million tonnes in the 1970s to more than 80 million tonnes in 2015 (FAO, 2018b). Some over-exploited fish stocks can recover when sustainable fishery management systems are implemented, as highlighted by the bluefin tuna fishery in the Mediterranean (Rouyer *et al.*, 2018), but once an ecological threshold has been passed, changes cannot be reversed (Ben Rais Lasram, Menard and Cury, 2018). For the future, new threats are likely to create fresh pressure on wild stocks: climate change, pollution (including plastic nanoparticles), habitat degradation etc.

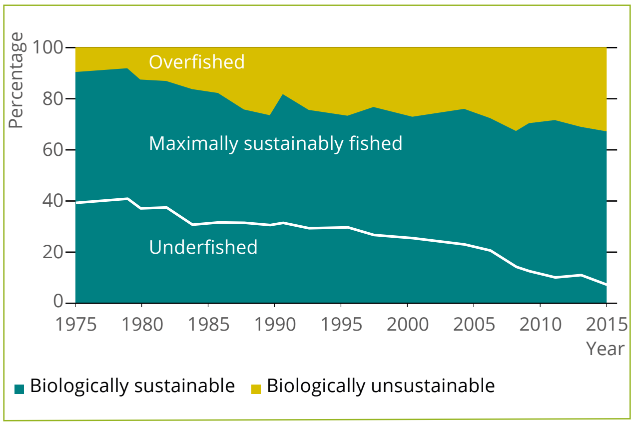

Figure 16: *Evolution of the sustainability of capture fisheries production (1975-2015). Source FAO, 2018b.*

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