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Can we improve global food security? A socio-economic and political perspective

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Abstract Ensuring global food security for a growing population remains a major challenge. This is especially true against the background of increasing food prices paired with growing income levels and changing demand patterns in the developing world. At the same time, climate change and the occurrence of more frequent and extreme natural disasters increase the vulnerability of rural farm households, negatively affecting agricultural production. Given the many dimensions of food security, no simple solution can be found. Promoting productivity of farming and increasing the efficiency of the food marketing system are effective measures contributing to rural development in developing countries. Policy reforms in agriculture and beyond help to reduce distortions and change consumers' awareness with respect to food waste and resource use inefficiencies related to human diets. What is new in this context is the increasing link of agriculture with other sectors such as the energy and the financial markets. This calls for further research as additional pressure is being put on the global food system.

Keywords Food security · Food system · Globalization · Climate change · Policy reform · Footprint

Introduction

Can we improve global food security? Will we be able to produce enough food with fewer resources at affordable prices in the future? By 2050, we will have a world population of an estimated 9.6 billion people (UN 2013). This means that the current population of 7.2 billion will grow by about one third. The growth is expected to happen mainly in developing countries with Sub Saharan Africa (SSA) having the world's highest fertility rates (UN 2013; World Bank 2007). At the same time, per capita incomes are expected to increase in many developing and transition countries so that total food production must grow by an estimated 70–100 % (FAO 2009b; Royal Society of London 2009). Against this background, it seems to be no easy task to improve food security worldwide. "Business as usual" is not likely to achieve it.

This paper deals with these and related pressing issues by highlighting the economic, social and political perspective. It draws on secondary literature from the respective disciplines and thus aims at contributing to an improved understanding of the complex links between agriculture, poverty and vulnerability, globalization and environmental change. The structure of this paper is as follows: in the next section, a brief overview of the current food security situation is provided, followed by an analysis of the causes of food insecurity. The fourth section elaborates on interventions that have the possibility of improving the situation. The last section is a summary and draws conclusions.

The status of global food security

Food security is defined as a situation "when all people at all times have physical and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life" (World Food Summit 1996). This concept is based on the four pillars of availability, access, use of food and stability. The availability of food depends on domestic production and/or imports, while access to food refers to individuals who need to have adequate resources or entitlements for obtaining food. The use of food depends on adequate diets, nutritious values of food and clean

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water, and stability ensures that food can be accessed at all times (FAO 2006).

Currently, sufficient food is available worldwide. Nevertheless, there is a food security problem—a very complex and multidimensional one. On the one hand, the situation of food security is characterized by hunger and micronutrient deficiencies of millions of people. About 12 % of the world population is chronically undernourished in terms of energy intake. This is equivalent to close to 870 million people of whom roughly 850 million live in developing countries (FAO, WFP and IFAD 2012). In addition, around 2 billion people suffer from one or more micronutrient deficiencies, and in 2012, around 17 % or 97 million children under the age of five were underweight (WHO 2013a,b). As is well known from the literature, nutritional deprivation at an early age hinders children's cognitive and physical development, thus reducing their abilities to earn a decent living through productive labor at a later stage (Victora et al. 2008). The costs of undernutrition and micronutrient deficiencies which are caused by lost productivity and direct health costs are estimated to reach some $ 1.4–2.1 trillion annually or 2–3 % of global GDP (FAO 2013a).

On the other hand, more than 1.4 billion adults above the age of 20 are overweight, with 500 million of them being obese[1] (WHO 2013c). This is equal to about 35 % of all adults aged 20 years and older being overweight and 12 % being obese worldwide. Overweight and obesity are most prevalent in upper-middle and high-income countries, namely the Region of the Americas, the Eastern Mediterranean Region and in Europe. The lowest figures are to be found in South-East Asia, followed by the African and the Western Pacific Regions (WHO 2011). Deaths due to non-communicable diseases (NCD)[2], for which overweight and obesity are leading risk factors, are predicted to increase worldwide by 15 % between 2010 and 2020 (WHO 2011). The cumulative cost of all NCDs amounted to an estimated $ 1.4 trillion in 2010 (FAO 2013a).

In order to capture the worldwide distribution of food insecurity, the Global Hunger Index (GHI) has been developed by the International Food Policy Research Institute (IFPRI), Concern Worldwide, and Welthungerhilfe (Fig. 1). The GHI considers the proportion of undernourished people, the proportion of children below the age of five who are underweight, and the mortality rate of children below five. These three metrics indicate the state of food security in a country. At the global level, the GHI shows that there have been small improvements in food security since 1990. However, the regional differences are still huge. South Asia and SSA are the regions with the highest GHI scores, indicating country-specific shortcomings in ensuring food security.

In fact, we find that in relative terms, food insecurity is most prevalent in SSA with the highest proportion of food insecure people in the total population: nearly a quarter of a billion people are hungry—one in four in 2010–12 (FAO, WFP and IFAD 2012). The absolute number of those who were food insecure even grew from 175 million in 1990–92 to 239 million in 2010–12. Absolute figures in densely populated Asia are much higher with the number of hungry people amounting to about half a billion. This is equivalent to two thirds of the world's hungry. However, progress in reducing the number of undernourished people has been considerable in Asia decreasing from about 24 % in 1990–92 to 14 % in 2010–12. In Latin America and the Caribbean, about 8 % of the population is undernourished, equating to some 49 million people. In Oceania, these figures amount to 12 % and 1 million, respectively.

Obviously, the food problem is not only biological or technical but also one of access and use. Sen (1981) included this observation in his entitlement approach and used it to explain the occurrence of famines in some regions. Also, Devereux (2001) complemented the entitlement approach with a socio-political dimension by stressing the importance of non-market institutions. A new dimension was brought into the food security discussion by researchers such as Chambers and Conway (1992) with their livelihood concepts. The recent debates on the right to food, on fuel versus food, and on food speculation in financial markets finally stress the ethical and political dimension of food security (McClain-Nhlapo 2004). However, there is not only the growing nexus of food, energy and financial markets to consider, but also the increasing scarcity of natural resources, especially water, land and energy. These are factors that have long been underestimated in their importance for world food security (von Braun 2013).

The ecological footprint, which is the area needed to allow a sustainable standard of living for a single person, is already greatly exceeded. According to the Global Footprint Network and the European Environment Agency, the global use exceeded the capacity of the available land and productive oceans by 50 % in 2008—2.7 gha[3] per person compared with the availability of only 1.8 gha (WWF 2012). This discrepancy means that it would take 1.5 years for the Earth to fully regenerate the renewable resources that people used in 1 year and by 2050 humanity would require an equivalent of 2.9 planets to support the "business as usual" assumption.

[1] Overweight is defined as Body Mass Index (BMI)≥25 kg/m^2 and obesity as BMI≥30 kg/m^2.

[2] NCDs comprise mainly cardiovascular diseases, cancers, diabetes and chronic lung diseases (WHO 2011).

[3] One global hectare (gha) represents a biologically productive ha with world average productivity.

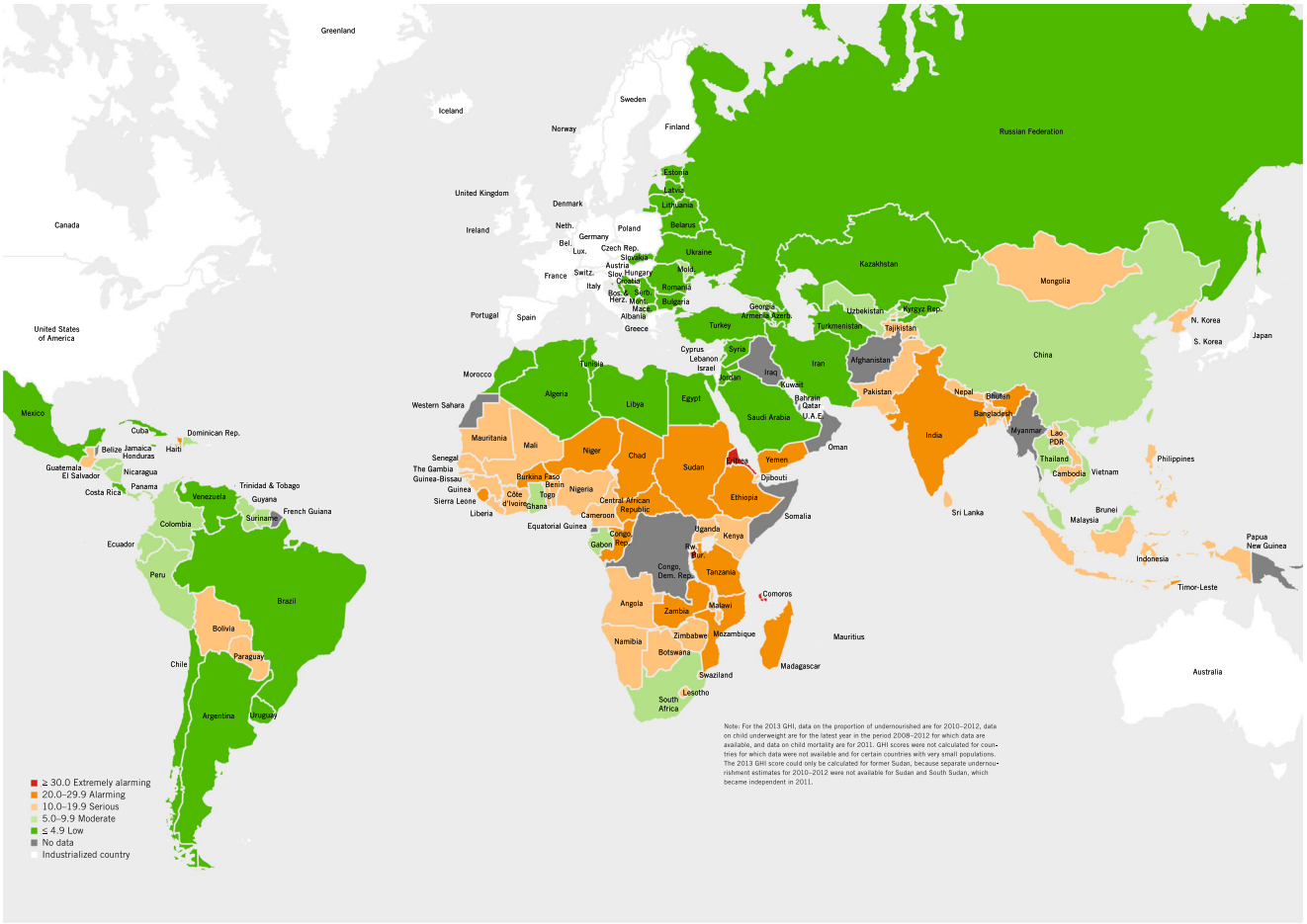

Fig. 1 The Global Hunger Index map, 2013. *Source*: von Grebmer et al. (2013). Reprinted with permission from the International Food Policy Research Institute

Causes of food insecurity

Food security has evolved over several decades as a multidimensional and complex approach. To shed some light on the interactive causes, which lead to food insecurity, we first look at the supply and the demand side of the production and consumption of food and other agricultural products (Fig. 2). The supply of food and other agricultural goods depends on the availability of and access to land and water. Production is often limited by depleted soil fertility, water scarcity and poor technologies paired with unskilled laborers. Also, climate change and natural disasters impact on production. On the demand side, population growth, urbanization and changing incomes and diets are determinants that trigger food insecurity—at least in some regions. Furthermore, the demand for agricultural commodities for the energy sector affects the demand for food.

But food security is not simply a function of supply and demand. It also depends on a number of market-related factors and institutions, which ensure availability, stability and access as well as affordability of high-quality and safe food. Hence, socio-economic constraints come into play such as volatile and high food prices, insecure property rights, inefficient value chains, food waste and losses along the value chains, trade or financial sector issues. Some of these supply and demand-side causes and market-related conditions are discussed in more detail in the following paragraphs.

Supply-side causes

Shortage of land

The availability of land is the dominant factor for the production of food. While, in theory, considerable land reserves exist worldwide, in practice, the feasibility of converting land reserves to agricultural production is limited. This is, in particular, due to location and the richness of ecosystem services that such land provides. Thus, if land is located in remote areas in large countries (Latin America) or in countries with poor infrastructure (SSA), access and use of the land are restricted. Similarly, if the land provides important provisioning, regulation or supporting ecosystem services such as wild foods, timber or flood regulation, conversion into arable land would result in a loss of these ecosystem services. Nevertheless, it is

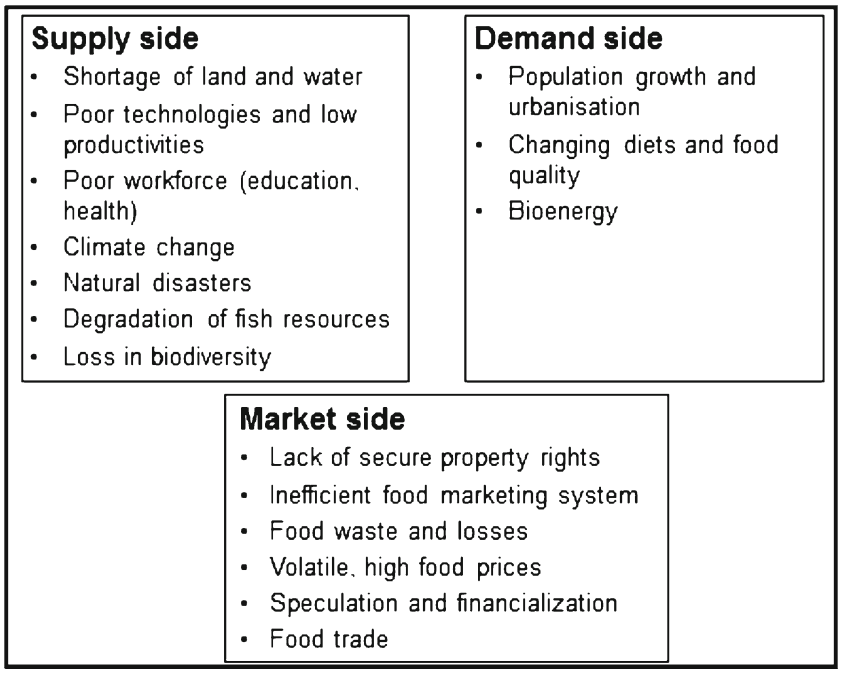

Fig. 2 Causes of food insecurity. *Source*: Own presentation

estimated that by 2050, land degradation, urban expansion and conversion of cropland for non-food production such as biofuel commodities will reduce the availability of agricultural land by 8–20 % (Nellemann et al. 2009).

The largest land reserves are available in Latin America and SSA, and it is estimated that more than 80 % of future land expansion will take place in these two regions (Bruinsma 2009). In Latin America, around 200 million hectares (ha) of arable land were in use in 2005, and it is estimated that more than 800 million ha of additional land with potential for rainfed crop production could still be exploited. Similarly in SSA, slightly more than 200 million ha were in use in 2005 and close to 800 million ha of additional land are still available. This contrasts especially with the situation in the Near East and North Africa, but also South and East Asia. In the Near East and North Africa, less than 100 million ha were in use in 2005 and the extra potential is almost negligible. In South Asia and East Asia, slightly more than 200 million ha were in use in each region in 2005, but while in South Asia, the potential for crop expansion is close to zero, in East Asia rather more than 100 million ha are still available (Bruinsma 2009).

Since the year 2000, around 200 million ha of land were bought in developing countries. This is equivalent to twice the size of France and Germany taken together. The food crisis in 2008 accelerated the scale and intensity of the purchase of arable land (Sutherland et al. 2010) as did the desire for the large-scale production of food and commodities for bioenergy. Also the purchase of land may be motivated by improved access to water for irrigating the agricultural land (UNCTAD 2009). Figures for the top ten investor and target countries are available from the Land Matrix Project, a global and independent land monitoring initiative on transnational land deals (Land Matrix 2013). It is striking that seven of the top ten target countries are located in SSA (South Sudan, DR Congo, Mozambique, Sudan, Liberia, Sierra Leone and Madagascar). For each target country, a large number of different investor countries can be identified. The top investor countries are the United States (USA), Malaysia, Arab Emirates, United Kingdom (UK), India, China, Saudi Arabia and three smaller countries, Singapore, Hong Kong China, and South Korea.

Shortage of water

The availability of fresh water reserves shows a similar picture to that of land. At the global scale, sufficient capacity is available, but it is very unevenly distributed so that, regionally, water shortage increasingly restricts agricultural production. Renewable water resources are scarce, especially in the Near East and North Africa, but also in South Asia and SSA, whereas abundant water is available in Latin America and the Caribbean, as well as in East Asia.

Irrigation is prevalent in water scarce South Asia and in East Asia, but to a lesser extent in the Near East and North Africa. Globally, irrigated agriculture covers one fifth of the arable land and contributes nearly 50 % of crop production. Hence, it makes agriculture extremely productive. During the second half of the 20th century, the world's irrigated area nearly trebled, expanding from 94 million ha in 1950 to 276 million ha in 2000. However, since then, the irrigated area per person has been shrinking by about 1 % per annum.

Along with climate change and more frequent and severe droughts, water scarcity has grown in developing and also many transition countries (Rosegrant, Ringler and Zhu 2009). At present, about 2.4 billion people–or 36 % of the world population–live in water scarce regions (IFPRI et al. 2012). At the same time, water pollution is on the rise, leading to severe health hazards from contaminated food and drinking water (UNESCO 2013).

Poor technologies and low productivities

It is estimated that only 20 % of the necessary production increases up to 2050 would come from the expansion in arable land but 80 % from increases in yields and cropping intensity (Bruinsma 2009). However, productivities in agriculture (cereals and livestock) vary widely across countries and regions — even if their climates are comparable. The average yield in cereal production amounts to around 5 tons (t) per ha across the EU (EU 2010), some 3 t per ha in the whole developing world, but to only around 1.2 t per ha in SSA. This can be partly explained by the low use of fertilizer which amounted to only 13 kilogram (kg) per ha in SSA in 2002, as compared to 73 kg in the Middle East and North Africa and 190 kg in East Asia and the Pacific (FAO 2009b). Although SSA is a net importer of nutrients in agricultural commodities, these nutrient imports do not alleviate the declines in soil fertility because the nutrients imported are commonly concentrated in cities, contributing to waste disposal problems (Grote, Craswell and Vlek 2005).

In the more recent decades, growth rates of yield have slowed considerably in many developing countries. This is also true for major commodities. In particular, the growth rates of cereal yields have been falling since the Green Revolution. They dropped from 3.2 % per year in 1960 to 1.5 % in 2000 (FAO 2009b). Nellemann et al. (2009) estimate that forecasted yields may be short of demand by 5–25 % by 2050 due to climate change, land degradation, cropland losses, water scarcity and pests and diseases.

The reasons for the current yield gaps[4] are diverse. Very often, farmers do not have sufficient economic incentives to adopt improved seeds or other technologies. This can be explained by the lack of access to information and extension services, or capital, poor infrastructure including irrigation systems, or poor agricultural policies. Other factors explaining the yield gaps are related to the poor adaptation of technologies and innovations to local conditions. New technologies should make plants and livestock more resistant to biotic stresses (e.g. pests and diseases) and abiotic stresses (e.g. droughts, floods and salinity) (FAO 2009b).

[4] The differences between realized and achievable productivities are the so-called "yield gaps" but see Sumberg (2012)

Poor workforce

Unskilled workforces with low levels of education, including self-employed farmers, often hamper the adoption of innovative technologies. Also, production by women in developing countries would increase by 20–30 % if they had the same access to information, education and inputs as men do (FAO 2009a, b). The benefits could be even greater, as women tend to spend more of their income on the education and health of their children. However, not only poor education but also health problems are responsible for low productivity and inefficiencies in production. In SSA, the persistence of, for example, HIV/AIDS is very pronounced with around 70 % of all people being infected (WHO/UNAIDS/UNICEF 2011). This drives food insecurity in many regions owing to neglected farm work because of the illness of household members. In turn, this leads to excessive workloads for the healthy, limits entry into the workforce and causes high attrition rates of workers without replacement. In Malawi, the country's agricultural output decreased by 14 %, mainly due to the reduced agricultural workforce (BBC 2005b) and in Mozambique, Botswana, Namibia and Zimbabwe, the reduction amounted to over 20 % (UNAIDS 2006).

Climate change and natural disasters

Climate change affects agriculture through higher global temperatures, more or less and greater variability of precipitation. It is expected that the greatest suffering will be in countries in the South owing to declining crop yields while countries in the North may even benefit from the higher temperatures. The total negative impact of climate change on African agricultural output up to 2080–2100 is estimated at 15–30 % (FAO 2009b). If no appropriate adaptation measures are taken, further decline of yields–up to 40 % are likely in Africa, Asia and Latin America (FAO 2009b). According to Boko et al. (2007), adaptation to climate change could cost Africa some 5–10 % of its Gross Domestic Product. They further predict that crop yields from rain-fed agriculture could decline by 50 % by 2020 in some African countries; by 2100, crop net revenues could even fall by up to 90 %. Parry et al. (2009) estimate that climate change may put an additional 10–20 % of the world population at risk of hunger by 2050. Nelson et al. (2009) found that the negative effects of climate change were especially severe in SSA and Southeast Asia and all major crops would be affected. In addition, the number of malnourished children will increase by up to 21 % by 2050 due to climate change. This effect is also expected to be greatest in SSA.

Not only climate change per se, but also the occurrence of more frequent and severe natural disasters is expected to reduce agricultural productivity in Southern regions. Figure 3 shows the development of natural disasters over the last two decades. Floods and storms, especially, increased over time,

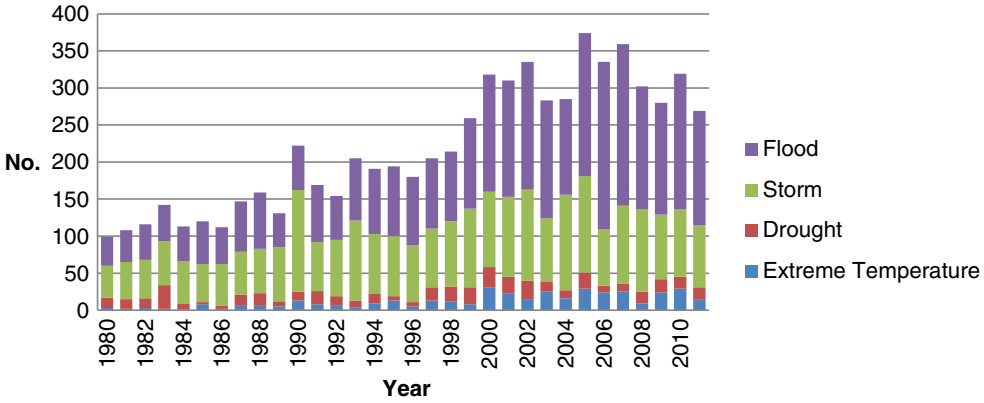

Fig. 3 Number of climate-related disasters around the world (1980–2011). *Source*: Based on data from United Nations Office for Disaster Risk Reduction (UNISDR), 2012

but also events with extreme temperatures occurred more often (UNISDR 2012).

Natural disasters such as droughts and floods are likely to trigger rural–urban migration and accelerate the overall increasing trend of urbanization (Grote and Warner 2010). As the BBC news reported in 2005, "natural disasters in the previous year had created more refugees than wars or other armed conflicts…In poorer rural areas especially, one of the biggest sources of refugees is land degradation and desertification… A second issue is flooding…" (BBC 2005a). Overall they conclude that millions will flee degradation with major repercussions for global food security.

Degradation of fish resources

Fish and fishery products play a critical role in sustaining food security. They are either directly used for human consumption, or they ensure access to food by providing entitlements via livelihoods or as export earnings. As a local food, fish provided about 3 billion people with almost 20 % of their animal protein intake in 2010. Next to being a valuable protein source, fish contain essential micronutrients, which are conducive to a balanced diet and good health for the poor. The per capita supply of fish increased from an average 9.9 kg (live weight equivalent) in the 1960s to 18.4 kg in 2009. However, there are huge regional differences in fish consumption, being lowest in Africa at 9.1 kg per capita, while in Asia, which accounts for two-thirds of total consumption, it was 20.7 kg per capita (FAO 2012). Fisheries and aquaculture are also important sources of employment, which was estimated at 54.8 million people in 2010 (FAO 2012).

Globally, the supply of food from fish has grown dramatically in the last five decades. Accordingly, the share of non-fully exploited stocks has decreased gradually since 1974, while the share of overexploited stocks had increased from 10 % in 1974 to 26 % in 1989. Thereafter, the number of overexploited stocks still grew but at a slower rate. Most of the stocks of the top ten species, which account for about 30 % of global capture, are fully exploited (FAO 2012). In the future, production is unlikely to increase further as there are no major new fishing grounds and most of the captured species are overexploited (FAO 2012; Godfray et al. 2010). Instead, aquaculture is expected to grow considerably, providing that technical advances are adopted in such areas as breeding systems, feeds and feed-delivery systems, and disease management. Poor management of aquaculture may result in negative environmental externalities due to the use of antibiotics or other chemicals.

Loss in biodiversity

Biodiversity continues to decline. The population of wild vertebrate species (birds, mammals, amphibians) fell between 1970 and 2006 by nearly one-third worldwide, with the reduction being especially severe in the tropics (59 %) and in freshwater ecosystems (41 %). According to Nellemann et al. (2009), more than 80 % of all endangered birds and mammals are threatened by unsustainable land use and agricultural expansion. Numbers of farmland birds in Europe have halved in the last 30 years owing to agricultural intensification. Also tropical forests and wetlands continue to be lost at rapid rates, as well as marine and coastal ecosystems (CBD 2010). Finally, genetic diversity is being lost in natural ecosystems and in farming systems. The reasons for these declining trends encompass habitat loss and degradation, climate change, excessive nutrient load and other forms of pollution, overexploitation and unsustainable use, and invasive alien species (CBD 2010).

With the loss of biodiversity, there is also a growing concern about food security. Biodiversity plays critical roles in increasing and sustaining food production and nutritional diversity. Genetic diversity especially has contributed to resistance to pests and diseases and has enhanced nutritional values in terms of protein and vitamin content, with substantial economic returns from investment in this field (Nellemann et al. 2009). As the Chicago Council on Global Affairs (2013) pointed out, agriculture nowadays depends heavily on only a few crops so that a single plant disease has the potential to

cause a food crisis. For example, most of the wheat grown is susceptible to a highly-virulent strain of wind-born stem rust sweeping across Eastern Africa and the Middle East. Also, in the past, Azerbaijan, Ethiopia, Iraq, Morocco, Syria, Tajikistan and Uzbekistan have been affected by yellow rust epidemics, with yield losses of up to 40 % (Cornell Chronicle 2012).

Nellemann et al. (2009) have stressed the heavy dependence of agriculture, natural ecosystems and biodiversity on water resources. Loss of biodiversity is accompanied by a loss of other ecosystem services such as the provision of food and fibre, regulation of air, water and climate, purification of water, protection against natural disasters, pollination and pest control (Nellemann et al. 2009).

Demand-side causes

Population growth and urbanization

The current population of 7.2 billion will grow by about one third. Thus, by 2050, we will have a world population of an estimated 9.6 billion people (UN 2013). The growth is expected to happen mainly in developing countries with SSA having the world's highest fertility rates (UN 2013; World Bank 2007).

By 2050, more than 70 % of the world population is expected to be urban as compared to the current~50 % (FAO 2009a). Most of this growth will happen in developing countries with unprecedented rates of urbanization in Asia, Africa and the Middle East. Cities in Latin America have already reached or exceeded levels comparable to those in Europe, North America and Australia (UN-Habitat 2010).

Changing diets and food quality

Urbanization has brought with it changes in life styles and consumption patterns. As urbanization occurs and personal incomes rise, people tend to eat more diversified food including meat and milk products. In China, for instance, annual per capita consumption of meat has risen from 9 kg to more than 50 kg within a period of 30 years. In the rest of the developing world, the average annual per capita meat consumption amounts to an average of 16 kg, indicating a significant future potential for growth (FAO 2011). To compare, the average annual per capita meat consumption in France amounts to around 100 kg and in the USA to 125 kg. Accordingly, it is estimated that by 2050, around 200 million t of meat and one billion t of cereals will need to be produced additionally each year (FAO 2009b). The increasing demand for meat and milk products means that more crops are needed as feed, rather than being used for direct human consumption. Thus, about half of the grain produced in the world is used to feed livestock.

Diets are also shifting towards more semi-processed or ready-to-eat foods as more women tend to work and thus their opportunity costs rise. At the same time, the demand for high quality food has grown. This is reflected in the increased use of environmental and food safety standards along the value chains, and the labeling of food products.

Bioenergy

The demand for agricultural commodities such as palm oil, canola oil, sugar cane, or maize for biofuel production increased more than three fold between 2000 and 2008 (FAO 2009b). Thus, the agricultural sector is increasingly considered as a producer of energy, and further growth is expected in the future. The rapid rise of fossil fuel prices and various policy measures such as mandated blending of renewable fuels with fossil fuels or tax incentives have promoted this development[5]. As the increasing policy-driven demand in developed countries, such as the EU and the USA, cannot be covered by own production, international trade in bioenergy commodities has increased massively. As a result, developing countries have started to expand their production of bioenergy commodities. However, it is estimated that in order to achieve a 10 % substitution of fossil fuels in the USA, Canada, and the EU, 30–70 % of the currently used agricultural area would need to be used for the production of energy crops (OECD 2006). A further rise in the use of agricultural commodities for the production of biofuels is a real threat to food security, especially in SSA. Of particular concern are the possible adverse effects on food security for the poor and the food-insecure if food prices rise (Rosegrant et al. 2008). More recently, Tokgoz et al. (2012) have presented model simulations confirming a notable effect of biofuel production on agricultural commodity prices, which again translates into changes in consumption, calorie availability and food security, measured in terms of malnutrition risk for children. They also confirmed that bioenergy production puts pressure on land reserves, which could lead to loss of natural habitats or grassland.

Market-related constraints

Lack of secure property rights

Many people in developing countries lack secure land rights. However, there is evidence that secure land titles provide incentives, especially for small-scale producers to invest in land. These increased investments result in higher productivities and overall efficiencies (Deininger and Feder 2009). A

[5] The European Union adopted the Renewable Energy Directive (RED) in 2009 including a 10 % target for the use of renewable energy in road transport fuels by 2020.

study by Jin and Jayne (2013) from Kenya confirms that land rental markets promote farm productivity and raise the incomes of land-constrained farm households. However, it is more difficult to find evidence that secure land titles improve access to credit thus hampering the creation of capital due to missing collateral. Another concern, in the context of insecure property rights, has been voiced by Godfray et al. (2010) concerning poor communities being displaced by powerful interest groups. This displacement can derive from "land grabbing", or from large-scale investments in land combined with the right to water access for the land. The resulting limited access of poor communities to water has repercussions for their food security. Finally, there are also a number of examples related to intellectual property rights and biopiracy. Taking the example of Jasmine rice, Thailand faces major challenges to the protection of its genetic resources, on which the welfare and food security of large parts of the population, especially the poor, depend (Ngokkuen and Grote 2012).

Inefficient food marketing systems

Food marketing systems do change over time. With increasing incomes and urbanization, more food needs to be transported from the rural areas to the cities. Given high food prices, low- and middle-income urban people are more likely to turn to readily accessible and affordable street foods. But while clean and nutritious street foods positively impact on food security, low quality and unsafe street foods can have a negative effect. Among the high-income population, the demand for high quality food is growing. That means that consumers pay more attention to the way certain food products have been produced, processed and even transported. The role of environmental and food safety standards increases along with the labeling of food products. Especially smallholders from developing countries may fail to adjust to these more stringent standards required by wholesalers, retailers and processors.

The fragmentation of the food value chains by numerous middlemen in developing countries exposes them to different kinds of fraudulent practices such as mislabeling, or replacing and adding something of lower value. Given that the food might be of lower nutrient content or even be contaminated, this does impact on public health and thus on the food security of poor people.

Food waste and losses

Inefficiencies in the food value chains from production via trading and processing to consumption result in major waste and losses. Currently, around 30 % of food is wasted worldwide; some estimates are even higher −50 % (House of Commons 2013). Eliminating food loss and waste is expected to feed 870 million chronically undernourished people worldwide (da Silva 2013). Or, in other words, around 30 % of the agricultural land is used for the production of food, which is not consumed (House of Commons 2013). But the reasons, which lead to food waste, are diverse. FAO (2013b) estimates that around 54 % of the waste occurs upstream at production/postharvest/storage stages, whereas the remaining 46 % waste happens downstream towards the end of the food chain, namely at the processing/distribution/consumption stages. Upstream, food is mainly lost due to pests and diseases and adverse weather conditions or as a result of natural disasters. Additionally, losses occur due to poor production techniques, harvesting methods or drying and processing techniques. Also, insufficient types and availability of storage facilities result in food rotting before it can be sold in the market. It is estimated that, owing to these upstream problems, Africa currently loses enough grain to feed 48 million people for a year (da Silva 2013). Food waste at consumption levels varies much more by region, amounting to between 4 and 16 % in developing countries and up to almost 40 % in high-income countries (FAO 2013b). Consumers tend to buy too much food partly due to special marketing promotion campaigns in supermarkets and then throw it away after its shelf life or expiration date has passed. Restaurants also waste a considerable amount of food.

High, volatile food prices

Food price is an indicator of the availability of food. Over the past century, there was first a general drop and then a leveling of gross food prices, interrupted by price spikes such as that in the 1970s caused by the oil crisis (Godfray et al. 2010; Nellemann et al. 2009). More recently, price increases of 50–200 % for key food commodities such as maize, wheat, rice and soybeans resulted in the global food crises in 2008–09 and 2010–11 (Fig. 4). This greatly affected the lives and livelihoods of millions of people (FAO 2009b). In total it is estimated that some 110 million people were driven into poverty and an additional 44 million became undernourished due to the food price crises (Nellemann et al. 2009). Ivanec et al. (2011) found from their simulations that the food price hike in 2011 pushed 68 million people into poverty while pulling 24 million out of poverty, leading to a net increase of 44 million poor. The affected groups are particularly urban consumers, who do not produce any food themselves but rather depend on buying it, rural net buyers who might be landless and also depend on buying food—often spending 50–90 % of their income on food—and even rural net sellers who might first benefit from increased food prices but only if food inflation does not push up overall inflation (von Braun and Tadesse 2012; Ruel et al. 2010).

The FAO listed over 30 countries for which the food price hikes have been dramatic; 19 of these are in Africa. Many of these are already characterized by civil war and/or general insecurity. The food price hikes resulted in further

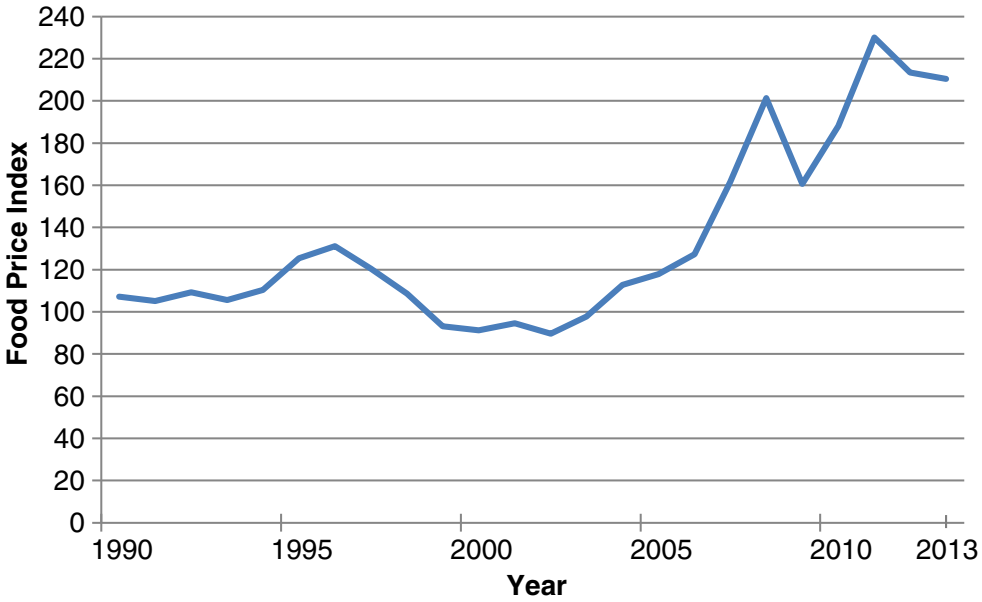

Fig. 4 Development of the food price index, 1990–2013. *Source*: Based on data from FAO 2013a

demonstrations and social unrest. Lagi, Bertand and Bar-Yam (2011) counted 35 food riots in Africa and the Middle East between 2007 and 2011. Some of the food riots even resulted in considerable death tolls as in Yemen, Libya or Tunisia.

Volatile and high food prices result from both supply-and demand-side causes. On the supply side, natural disasters such as droughts and floods are especially responsible and these are followed by low global grain stocks as a second important cause (Stoeckel 2008; Meyers and Meyer 2008). Furthermore, high fossil fuel prices resulted in a rise in input prices such as fertilizer or pesticides, hampering overall agricultural production (Anderson 2009). On the demand side, rising fossil fuel prices increased the attractiveness of biofuel production from grains and oilseeds, which is seen as an important contributor to the recent price hikes (Cotula et al. 2009; Mitchell 2008). However, the production of biofuel commodities was also driven by energy and climate policies aiming at finding alternatives to fossil fuels and reducing carbon emissions; especially the governments in the EU and the USA started to subsidize domestic biofuel production via tax credits and the introduction of mandates on biofuel use. Furthermore, population and income growth drove up prices in the recent past due to an increased consumption of high-protein foods (Anderson 2009). These two factors are also expected to drive up world market prices by around 40–70 % for the most important crops by 2050 (Nelson et al. 2009). Nellemann et al. (2009) forecast a 30–50 % increase and more volatile food prices in the coming decades.

Speculation and financialization

More volatile prices are partly caused by increased speculation on agricultural commodity markets. The volume of futures and options increased six fold between 2002 and 2010 (BMELV 2013). Speculation per se is not a bad thing. It helps producers and traders to solve liquidity problems or to hedge against risk. However, if led by manipulative behavior of market participants, it is assumed to influence price development. Von Braun and Tadesse (2012) found that the speculation effect was stronger than demand- and supply-side shocks for short-term price increases.

Also financialization[6] of natural resources and ecosystem services has increased over time, a multitude of innovative products entering the financial market (Köllner 2008). However, financialization has become an issue of concern as the value of natural resources grows with their increasing scarcity over time. The incentive to speculate and to maximize short-term financial returns with them becomes more attractive with potential damage to the environment (Grote and Winter 2013). In addition, market agents need to have a very good understanding of the value of natural capital as being part and result of a very complex and interlinked process (Köllner 2008).

Food Trade

Trade becomes increasingly important as climate change will shift not only growing seasons but also production sites and yields (Nelson et al. 2009). Many least developed countries, especially in Africa, have become dependent on food imports in the last couple of decades. They benefited from relatively low priced imports from OECD countries due to the high

[6] Financialization refers to the "increasing importance of financial markets, financial motives, financial institutions, and financial elites" in the management of natural resources (with reference to a definition by Epstein 2002).

levels of farm subsidies in the past. But increasingly imports to developing countries also arise from the growing diversification of diets of urban, better-off households. This import dependency is expected to continue and even increase in the future up to 2050, despite increasing food prices and it is particularly true for cereal imports by developing countries, especially those in the Near East and North Africa. With respect to other major commodities such as oilseeds or vegetable oils, net exports from developing countries are expected to grow more than threefold by 2050, and net exports of sugar twofold (FAO 2009b). A growing differentiation in food production and demand will generally result in greater reliance on imports for many countries (Nellemann et al. 2009).

Interventions to improve food security

What kinds of interventions are needed to improve global food security? From the 1950s to the 1980s, the Green Revolution, as initiated by Norman Borlaug, introduced new high-yielding wheat and rice varieties and innovations such as fertilizers, pesticides and irrigation. This had tremendous positive impacts on the food security situation in Latin America and in large parts of Asia. The success of the Green Revolution was also triggered by an enabling economic and political environment (Hazell 2009). Without the markets, which could handle the distribution of the increased production and without the financial support of governments, it is unlikely that the Green Revolution would have taken off.

Increasing agricultural production, based on the development of research, education and infrastructure, is still important but not sufficient. Instead, a new and more complex green revolution is warranted which increases efficiencies in the whole agribusiness sector given the growing scarcity of natural resources. A single solution will not be enough! Conway (2012), in his new book entitled "One billion hungry–Can we feed the world?" draws attention to new challenges such as the recent price spikes in food, the persistence of poverty and hunger, and climate change. He calls for a broad approach to change, going even beyond his earlier suggested "doubly Green Revolution" (Conway 1997). Godfray et al. (2010) suggest changes in the food systems, which are "as radical as those that occurred during the 18th- and 19th-century Industrial and Agricultural Revolutions and the 20th-century Green Revolution". Wheeler and von Braun (2013) suggest actions toward a "climate-smart food system" that is more resilient to the negative effects of climate change on food security.

Against this background, three major areas are highlighted in the following sections, which are considered to be essential for promoting food security in the future: sustainable intensification, food system changes and policy changes.

Sustainable intensification

Producing more food on the same amount of available land while, at the same time, reducing the negative environmental externalities is called "sustainable intensification". The Montpellier Panel (2013) suggests innovations that will increase the production of and access to nutritious food, conserve land and water, allow adaptation to climate change, reduce environmental impact and reduce food waste along the supply chain. Thus, it demands more than just inputs and technical support. It also requires increased cooperation and organization in rural areas, such as "grain banks" to help small-scale farmers to protect their harvests and quick access to networks providing information on prices.

Further suggestions relating to sustainable intensification are integrated plant nutrient management systems, integrated pest management or new irrigation systems, including water harvesting techniques, next to zero or reduced tillage and precision agriculture. Reduced tillage for example reduces inversion ploughing, and precision farming optimizes the use of inputs (water, fertilizer and pesticides) by allowing the application only to the places and at the times they are required. Many of these farming approaches have already been applied in the developing world. They help to save not only inputs such as fertilizers and pesticides but also fuel and water. Additionally, they improve soil fertility and increase yields. However, they are knowledge intensive and require extension services.

Food system changes

As has been noted earlier, supplying food to urban residents has become a new challenge with the accelerating rate of urbanization. Transformation of food systems is needed to adjust to this challenge. Changes in the organization of food markets are essential, not only because of the rising demand for more diversified food but also because of the increasing traffic and changing modes of transport in the fast growing cities and because of changing standards and technologies (FAO 2013a). Large urban markets create the scope for supermarkets to be established.

These high-value markets for domestic consumption are the fastest-growing agricultural markets in most developing countries. They expand at a rate of up to 7 % per annum. Their impact on poverty depends on how the rural population participates in them, either directly as producers or through the labor market (World Bank 2008). While supermarkets are likely to provide new employment opportunities, they will also put pressure on small-scale farm households.

The increased integration across food value chains will influence the organization of food production. In order to enhance the participation of small-scale producers, contract farming or outgrower schemes have increased in importance.

In addition, producer organizations help to achieve some market power and also increase production volume and decrease transaction costs. Between 1982 and 2002 the percentage of villages with producer organizations rose from 8 to 65 % in Senegal and from 21 to 91 % in Burkina Faso (World Bank 2008).

Participation of smallholders can also be promoted by improving their access to domestic markets dealing in staples. Given the growth in population, the market opportunities for domestic markets are very promising. However, poverty reduction has to be ensured as a result of agricultural growth. Reducing transaction costs and risks in staple food markets can promote growth and benefit the poor. This may be done via investments in infrastructure, commodity exchanges, market information systems based on rural radio and short messaging systems, warehouse receipts, or market-based risk management tools.

External investment in large-scale farming activities in developing-country agriculture may also bring major benefits, especially where investors bring considerable improvements to crop production and processing. But the rights and welfare of the local population including tenants and existing resource users have to be properly addressed (Godfray et al. 2010).

A more efficient trading system is also needed to promote food trade between surplus and deficit areas. Protectionist measures such as export bans have been found to further aggravate food price increases.

Policy reforms and increasing awareness

Achieving food security in developing countries is hampered by agricultural policies and now also increasingly by energy policies, especially in the EU and the USA. On the one hand, they provide famers with substantial subsidies — many of them still being coupled to the production of a certain agricultural commodity. On the other hand, access to developed countries' markets is still limited by high import restrictions and tariff escalation, limiting the value addition and processing in developing countries. In sum, these policies create distortions on international and developing country markets by artificially lowering world market prices, reducing import demand, or by limiting access to potential markets (FAO 2009b). Furthermore, export subsidies still exist in some developed countries, especially the EU. These also have a strong distortionary effect as they allow surplus production to be exported to developing countries depressing world market prices.

In developing countries, policy reforms are needed which reduce the historical biases against agriculture. While between 1980–84 and 2000–04, net agricultural taxation declined on average from 28 to 10 % in agriculture-based countries, a low level of net taxation still hides a combination of protection of importables and taxation of exportables (World Bank 2008; FAO 2009b). Input subsidies are provided to very different extents to farmers in developing countries. Especially in countries such as in SSA where the use of fertilizer is at very low levels, soil fertility may benefit from increasing input subsidies. Over time, soil fertility has declined massively in SSA, while, for example in East Asia including China, agricultural production has suffered from overuse of fertilizers (Grote et al. 2005).

Consumer policy should generally try to increase awareness of the nutritional values of food, the large inefficiencies in production of some foods such as meat and the massive losses and waste, which could be avoided. The low awareness of nutritional values of different foods and hygienic risks are especially prevalent in many developing countries. In developed countries, high levels of livestock consumption and of waste are responsible for the inefficient use of scarce resources. As Ash et al. (2010, p. 797) have put it: "…the quest for food security may require us all to reconsider our eating habits, particularly in view of the energy consumption and environmental costs that sustain those habits".

Summary and conclusion

By 2050, an additional 2.4 billion people will exist on the planet. This is equal to an increase of around 30 %. Due to increasing per capita incomes and changing diets, global food production will need to grow by 70–100 % in order to ensure global food security. The rising demand for biofuel crops is putting additional pressure on global food security. On the supply side, the development of productivities is most important for increasing total food production. Major constraints on food production are the shortage of land and water, poor workforces in developing countries and the effects of climate change and natural disasters. Food security also depends on the availability of fish resources and biodiversity, the former being overexploited and the latter being reduced by various human activities.

Despite the increasing pressures due to scarce and deteriorating natural resources, it is expected that the goal of feeding more than 9 billion people by 2050 can be met. The reduction of food waste and more efficient organization of food marketing systems are especially effective instruments for lowering the pressure on food production. Three major areas for action have been identified as particularly important for achieving food security in the future: (i) sustainable intensification, (ii) food system changes, and (iii) policy reforms along with increasing consumer awareness.

Sustainable intensification promotes productivity of farming, which allows the production of more food but with fewer inputs on the same amount of land. Food system changes are needed which promote an increased efficiency of food marketing without impairing rural development. Policy reforms in

agriculture, and beyond, help to reduce distortions on international and developing country markets and to change consumers' awareness with respect to food waste and resource use inefficiencies related to human diets, particularly meat consumption.

To understand the interrelations between upcoming changes and transformations, especially as regards the links between agricultural markets, energy markets and financial markets, and their effects on food security, new research is required. Gómez et al. (2010) stress the need to understand the consequences for poor people participating either as producers, workers or consumers in the marketing system. They suggest six guiding principles for multi-and interdisciplinary research "relating to the role of domestic markets, the unintended effects of interventions, the importance of market efficiency, the extent of post-harvest losses, the significance of on-farm conservation, and the need for cost-effective certification".

Against this background, there is a further challenge, namely to increase investment in agriculture in general and specially in agricultural research. The FAO (2009a, b) estimates that an average annual net investment of US$ 83 billion (in 2009 US$) is needed in developing countries to finance expansion of agricultural production in order to improve food security. This is equivalent to an increase of 50 %, demonstrating the current heavy underinvestment in agriculture. Without this investment, it will be difficult to meet the many challenges demanded by the goal of food security for all.

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