A sustainable and fair food system in the European Union

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1. Introduction

Undernourishment has largely disappeared in high-income countries. Food deficiency diseases are giving way to health problems caused by overnutrition. Meanwhile in the world at large, one billion people remain undernourished. The main cause is poverty, not a lack of supply. With on average 2800 kcal per day per person, enough food is available to feed the whole global population well[1]. However, accessibility and nutritional quality are still problems for many.

The current situation does provide no guarantee with regard to the future, when scarcity may become absolute. Further growth in world population and changing diets in emerging economies will raise the demand for food. It is estimated by the FAO that we need 70% more food by 2050 than we produce today[2]. At the same time, depletion of fossil hydrocarbons will increase the demand for biofuels and materials, which may compete for biomass with food. Food may become scarcer in the future, inducing higher prices. This is unlikely to threaten food supply in European Union countries directly. European citizens are likely to remain sufficiently affluent to buy their way out of any food scarcity. However, a tripling or quadrupling of international grain prices would entail security risks in destabilising neighbouring regions and prompting a run on land and water resources. In this regard, the food riots and land grabbing that were prompted by the brief food price spike in 2008 are telling.

The European Union is favourably endowed with land and water resources. The per capita availability of highly suitable agricultural land in the European Union is 0.12 hectare, against 0.07 hectare in the world at large. For moderately suitable land, the figures are 0.26 and 0.19 hectare, respectively.[3] If necessity increases, the European Union should be able to produce a large share of biomass for its population. This does not alter the fact that agriculture in the European Union is faced with sustainability problems and competing claims on natural resources. In addition, livestock systems may cause health risks for humans. Therefore, the question is how the EU can reduce health risks and ensure sustainable food security for itself and the world.

In this paper we briefly discuss the recent history of food scarcity. Thereafter, we address the present challenges for the global agriculture and we conclude with policy options for the EU to cope with these issues.

[1] FAO-statistics as accessed on April 3, 2010
[2] FAO (2009): Harvesting agriculture's multiple benefits: mitigation, adaptation, development and Food Security (policy brief)
[3] FAO-statistics as accessed on April 3, 2010.

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2. Interaction of humans and natural resources

Like other animals, humans extract food and other necessities from natural resources. They can increase the efficiency of their extraction through cultural (technical and institutional) evolution. In the course of time, this induced important changes in the dynamics of human food economies. In pre-industrial societies, a broad array of goods was made from farm-produced biomass. The supply growth was constrained by high transport costs, slow innovation and soil fertility. Demographic developments and economic upswings raised agricultural prices and cheapened farm labour. These price effects encouraged a shift to more intensive farming systems – usually led by more substantial entrepreneurs who were better equipped for innovations than small farmers. This resulted in 'agricultural revolutions' which allowed further population growth and prompted new spurts in non-farm activity and state formation. Sooner or later, however, pre-industrial societies outgrew their slowly evolving capacity for increasing food production. At such instances, food prices skyrocketed, leading to a check on population growth.

From the 19th century, the rise of technical science and the exploitation of fossil fuels – the remains of 2 billion years of natural biomass growth – have relaxed the traditional constraints for economic growth. They brought cheap transport that enabled the tapping of reserves for agricultural intensification; cheap fertilizer and plant varieties that could transform these fertilizers into harvestable product; and substitute products for farm-based non-food products. It opened a whole new potential for increasing the production of food, allowing a glutting of international markets, a squeeze on farm profits and decline of large farms with hired labour and a shift of labour to other sectors leaving the sector to self-employed farmers. They were caught in a treadmill of increasing output based on innovation and investment, and decreasing agricultural prices.

Where supportive farm policies were implemented (mainly in western and Asian countries), green revolutions became an engine of modern economic growth. Unlike in pre-industrial societies, this involved a progressive increase in per capita incomes. In turn, this induced a demographic transition. In a first phase, this involved a decrease in mortality, speeding up population growth, but further improvements in living standards induced a decrease in fertility and a demographic levelling. Failure to introduce supportive farm policies led to involution and stagnation (in smallholder regions) or to a socially exclusive modernization of large farms, leading to lopsided growth. Medical and other improvements still cause a reduction in mortality, but poverty prevents an adjustment of fertility, resulting in high population growth, and continuing low incomes. This unequal development of the world's regions is now likely to drive a number of robust trends that will strongly affect our common future:

- In spite of the demographic levelling in rich countries, rapid population growth in poor countries will cause a further growth in world population, be it a slower one than in the preceding decades. From the current 7 billion, world population is expected to increase to around 9 billion within the next three decades.
- Rising incomes induce a shift to diets with more animal based food products. In addition to cultural factors, a biologically evolved preference probably plays a role, which makes this shift a hard tendency. Although the consumption of livestock products in rich countries is now stabilising and is likely to decrease, that in developing countries with rising incomes is increasing, so that the global demand for animal based food products may double between now and mid-century. This will boost the demand for agricultural biomass, because producing one energy unit of animal (including fish) products requires several energy units of plant biomass as feed.
- Rising incomes increase the demand for the satisfaction of what Maslow has called the 'need for self actualization'. In many cases, this appears to include a demand for consumption landscapes and 'natural' goods (organic foods, etc.). This demand makes itself felt through product markets and political markets, and imposes constraints on the biomass to be extracted from natural resources.
- Rising incomes increase the demand for energy. Although the consumption of primary energy in rich countries is now stabilising, that in newly industrializing countries is increasing fast. The gradual depletion of global reserves of fossil fuels will raise extraction costs, even with improved extraction techniques. This will raise the demand for agro-fuels and agro-materials, reversing the earlier trend towards substitution. New bio-refinement techniques will have an ambivalent effect on this, moderating the demand for agricultural feedstock by improving conversion ratios, but increasing it by lowering the price of agro-based non-foods.

3. Present challenges

How to ensure food security?

Between now and 2050, growth in world population and change in diets in emerging economies is likely to cause a 70 percent increase in food demand.[4] The new demand for biobased fuels and materials will compete with the demand for food and other biomass products. At the same time, the sources of rapid supply growth in the 20th century are being depleted. Global land and water reserves are dwindling. Some regions retain significant room for irrigation, but elsewhere major grain belts are running dry[5]. Vast stretches of marginal land still exist, but exploiting them would require excessive amounts of inputs. In practice, a further expansion of agricultural area will mainly be at the expense of forests, which occupy more fertile soils. Rather than from new land reclamation, further increases in farm production should come from higher output per hectare. In for instance Africa there is ample room for raising crop yields by eliminating limitations

[4] FAO (2009): Harvesting agriculture's multiple benefits: mitigation, adaptation, development and Food Security (policy brief).

[5] N.B.J. Koning, M.K. Van Ittersum, G.A. Becx, M.A.J.S. van Boekel, W.A. Brandenburg, J.A. Van Den Broek, J. Goudriaan, G. Van Hofwegen, R.A. Jongeneel, J.B. Schiere, M. Smies (2008). Long-term global availability of food: continued abundance or new scarcity? NJAS wageningen journal of life sciences, Vol 55, No 3 (2008)

due to water or nutrient shortage or due to reduction of crop growth by pests, diseases and weeds. However, in the EU, the 'yield gap' between actual production and the potential yield of existing crop varieties is considerably smaller.

Although we do have options to increase biomass production, the fast development of the biobased economy may interfere. Less than a decade ago, bio-fuels were widely seen as a sustainable alternative for fuels derived from fossil oil. Today, bio-fuels raise much discussion about both their effectiveness and their detrimental effect on food security. For that reason, the attention shifted from the so-called first generation of bio-fuels to the second generation. The first generation uses food or food crops as feedstock, showing a clear competition between food and fuel. The second generation is not based on edible feedstock, and hence is considered as not competing with food[6]. However, most of the competition is not for feed-stock, but for scarce production resources like soil, nutrients and water. Obviously, when a farmer shifts his cultivation from an edible crop towards a non-edible bio-fuel crop, food production is affected. Driven by policies, subsidies or free market prices, farmers may indeed decide to shift on a large scale to dedicated bio-fuel crops. The land and other resources needed to have a substantial energy production are tremendous and manifold the resources needed for food production.

Productivity is not only limited by biophysical constraints. For one thing, producers maximize profit rather than output. For example, the depletion of global reserves of fossil fuels and phosphate rock will raise the costs of farm inputs, particularly fertilizers. In addition, producers face relatively high risks and transaction costs and unfavourable product price ratios in many regions. Consequently, they may opt for technologies that give a lower output per hectare. These may be efficient in certain circumstances, because simple production systems need fewer inputs for maintenance, but the effect is that global food supply will reach an economic ceiling before the biophysical potential has been exhausted. More generally, increasing output is constrained by diminishing returns. Pushing back diminishing returns requires investment in techniques and skills for increasing the production and conversion efficiency of biomass as well as strategies for mitigating the increase in biomass demand. This will need adequate policies.

One possibility for increasing the technical potential for biomass production is to raise the potential yield of crops. Here a factor to take into account is that the room for producing higher yielding varieties, using simple breeding techniques, is becoming smaller. Nevertheless, new techniques like F1-hybrids still allow a considerable increase in yield. A challenging option is the improvement of plant photosynthetic efficiency, a domain in which the European Union could take the lead. Besides yield, quality needs to be addressed. Much of the global agricultural research has gone into producing more calories (cereals), with little attention for protein and vitamin crops like vegetables in many regions of the world. As a result, output of such improved cereals is generally higher than that of other crops, reducing diversity in diets in many regions and thus challenging food security.

Another possibility for meeting the biomass demand is developing new non-farm biomass production systems. Ocean farming may disclose an enormous potential for marine biomass production. In particular, micro-algae are considered high potentials for energy and components. However, containment and control of nutrient flows in open water are still major challenges.

Biomass conversion can be improved by fractionating into separate components for further processing. Such bio-refinement may allow a fuller use of plants by separating high-value components for pharmaceuticals and fine chemicals from components for food and feed and residues for applications like generating energy. The presence of high-tech industries, well equipped ports, and excellent logistic and scientific infrastructures make the EU well placed for leading this development.

Improving global food security in the future may require measures to mitigate the increase in biomass demand as well as radical improvement towards access to food. A global social security system would moderate the growth in world population, which is extended by poverty. Speeding up the development of novel techniques for nuclear or solar energy might help to limit the demand for bio-energy. Effective meat substitutes may limit the consumption of livestock products, which require an input of plant energy of several times their own energy content. The human taste for livestock products makes it difficult though to develop substitutes that are widely accepted by consumers. Attempts at producing attractive meat substitutes from plants have failed, but fungi might offer better prospects.

The above options involve major investments in infrastructures, research and human capital. To avoid unnecessary scarcity, such investment should be made in time. The problem is that private and public investors have short time horizons. If current prices are high (low), they expect that prices will continue to be so in the future. Such expectations generate price fluctuations ('cobweb cycles') in agricultural markets by causing alternating overshooting and undershooting of trend investment. Indeed, the rise in food prices after 2005 was partly caused by low prices in the 1980s-'90s which resulted in reduced investment. This price rise may now prompt a rapid exploitation of the last options still available for a relatively cheap increases in global farm output that exist in countries such as Brazil or Russia. Again, this might induce a new price fall after some years and once more squeeze long term investment in the world's capacity for food production. If this were to coincide with a trend change towards increased scarcity, the result might be a period with strongly rising food prices likely to cause havoc in food importing poor countries.

[6] Sims, R., M. Taylor, J. Saddler and W. Mabee (2008). From 1st- to 2nd-Generation Biofuel Technologies. OECD/IAE.

How to make food production environmentally sustainable?

Any increased production must be environmental sustainable. This not necessarily means a reduction of inputs. In many poor countries, unsustainability is due to too little, rather than too much inputs. Lack of nutrients and water depletes the soil, leaving degraded soil which is no longer suitable for agriculture. In contrast, in many developed countries, unsustainability is the result of too much inputs. Over-usage of nutrients and pesticides will decrease the biological functionality of soil, and again lead tot degraded soils. A balanced application, based on ecological principles (by some referred to as ecological literacy), is needed for sustainability. Integrated Crop Management and Precision Agriculture will be powerful tools to answer these challenges.

In many countries, a large part of any yield is destroyed by pests and diseases. Controlling these problems will largely contribute to a higher productivity. To avoid overuse of pesticides, agronomic measures are needed. Genetic resistance may prove a powerful tool to avoid the use of pesticides. To fully capitalize on the possibilities of breeding, we suggest that genetic modification should not be excluded a priori. A regulated application of this technology which avoids monopoly power by patent holders may turn out to be more sustainable than refraining from the technique.

To prevent the depletion of phosphate reserves from constraining the growth in agricultural biomass production, strategies for preserving and retaining phosphate may be required. Among these are a more precise application (precision agriculture), increasing the nutrient-use efficiency of plants, and recycling. Phosphate is washed into the sea and sedimented, most of it in estuaries and coastal areas. Ocean farming might be used to regain this phosphate through phyto-mining.

How to reduce health risks of food production and consumption?

Agricultural production involves several risks to human health. Risks of pesticide use are now largely controlled in high income countries. However, animal production is still posing problems. The use of antibiotics in livestock farming stimulates the development of resistance to these drugs of various pathogens that can affect humans. Moreover, livestock production is a source of zoonotic diseases that may be transmitted to humans, and can even become transmittable between humans and lead to pandemics. Indeed, many infectious diseases stem from the interaction of people and livestock. The case of Q-fever illustrates that the risk is not limited to large-scale closed systems. A high concentration of small scale open systems may be even more risky. The highest risks for the European Union come from the spread of animal diseases from Africa and Asia due to increased global trade and climate change that support he spread of vectors, and from the large rings of semi-traditional livestock systems around Asian mega-cities, where pandemic diseases may emerge that spread to the rest of the world, including Europe.

A different health risk stems from over-consumption, especially of fats and fast carbohydrates. This stimulates disorders such as obesity, diabetes, certain forms of cancer and cardiovascular disease. These health problems are not easy to avoid in affluent societies, because they do not simply stem from food cultures but are rooted in evolutionary discordance. The biological evolution has equipped humans with a genetic outfit that stimulates them to eat large amounts of high energy foods (‘hungry gene’). This has helped our Pleistocene ancestors to survive when faced with an erratic supply of food, but is causing problems for citizens who have ample access to food.

The growing awareness of the relation between nutrition and health is leading to an avalanche of slimming diets and health claims for certain foods. The latter range from natural foods (like anti-carcinogenic broccoli) to fortified foods (like iodized salt or vitamin-enriched fruit juices) and nutriceuticals (like margarine supplemented with cholesterol reducing phytosterols or dairy products supplemented with beneficial microorganisms). This development has led to the emergence of an industry producing special health foods and a new branch of genetic research called nutri-genomics.

4. Policy conclusions

The European Union can do several things to ensure a sustainable, healthy and fair food system, internally and in the world at large:

- Agriculture should be based on ecological literacy and not focus on maximizing, but rather on optimizing production. Powerful tools are precision agriculture, integrated pest, disease and weed management and genetic modification. To avoid problems in livestock production, concentration of production may be a better strategy than dispersing production over a large area.
- Trade may contribute to an efficient division of labour between countries, including regions that are well endowed with land and water producing biomass for regions where these resources are scarce. Yet questions may be raised about the EU's strong dependence on imports of oilseeds and protein crops. In any case, in view of its relatively high per capita availability of suitable land and water, EU should always retain the possibility to turn its net food deficit into a surplus if the global situation would require so.
- The EU could raise its public investment in research for sustainable yield increases, nutrients recycling, bio-refinement, effective meat substitutes, and new nonfarm biomass production systems. Where possible, biodiversity conservation should be combined with agricultural production. Nature reserves and the like should be restricted to marginal lands. Organic agriculture should not be seen as a general model, because it cannot feed the world and may have negative environmental effects. Governments could discourage the consumption of livestock products with especially unfavorable feed conversion ratios (like feedlot beef).
- To moderate global population growth, EU could take the lead in creating a global social security system. To reduce poverty-induced hunger and increase food production in the developing world, it could support smallholder-based agricultural development in poor countries. This requires among other things an improved soil fertility management in regions like Sub-Saharan Africa, where lack of fertilizer is causing low yields and widespread soil degradation. To facilitate sustainable agricultural growth, it may be necessary to stop disturbing (through European Partnership Agreements) the formation of trade blocks of poor countries that support their internal agricultural prices. EU could make its development aid more effective by supporting agricultural research and infrastructural investment in poor countries. This latter could also be used for employment projects to compensate poor consumers for the first round effect of import restrictions on domestic food prices.
- Rather than stimulating the use of biofuels, EU could invest in new techniques for nuclear and solar energy. Second generation biofuels will not end the competition with food. Even if they are not based on edible feedstock, they will still compete with food crops for scarce soil, nutrient and water resources. Nor will the use of marginal lands solve the problem. Some crops may grow on marginal lands, but they will always grow better in rich soils and farmers are likely to choose the best soils for the economically most attractive crops. Unless bio-fuels are based on biomass that cannot otherwise be used, they will impact on food security.
- EU could reconsider the direction in which international agricultural trade reforms are moving. The current liberalization increases the scope for endogenous price fluctuations that may discourage timely investment in abilities for increasing biomass production. What is needed is rather a multilateral trading system that keeps agro-food prices within adequate price bands. This may require restrictions on using biomass for non-foods that are activated when international grain prices exceed a ceiling. Because agro-food and energy systems are becoming increasingly inter-related, stabilising agro-food prices cannot be done without stabilising energy prices.