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FAO's Long-term Outlook for Global Agriculture – Challenges, Trends and Drivers

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Agriculture in the 21st century faces multiple challenges: it has to produce more food and fiber for a growing population and more feedstocks for a potentially huge bioenergy market, contribute to overall development in the many agriculture-dependent developing countries, adopt more sustainable production methods and adapt to climate change. At the same time, there are still untapped productivity potentials, options for further efficiency gains arising from larger scales and better management and sufficient land and water resources available globally-despite some regional scarcity. The net effect of these factors on world food prices is difficult to gauge as far as their levels, their trends and the volatility around these trends are concerned.

Food demand and production

World population is expected to grow by over a third between 2009 and 2050, when it will reach 9.15 billion. While this represents an absolute increase of 2.3 billion people, it is a marked slow-down compared to the past four decades when the global population grew by 3.3 billion people and thus almost doubled. Nearly all this growth is expected to occur in developing countries. The biggest increase is foreseen for sub-Saharan Africa (+114%), the smallest for East and South East Asia (+13%). Urban areas will account for the entire growth and by 2050, 70% of the world's population will live in cities. By contrast, the number (and even more so the share) of people living in rural areas is expected to decline.

Overall, the world will not only be more populous, it will also be richer. Per capita incomes are projected to continue to rise and will in most countries climb considerably above their current levels. Analysts agree that developing countries will, on average, continue to grow faster than developed ones. The world will thus see a narrowing of relative income gaps between rich and poor countries, although absolute differences are foreseen to remain pronounced. Despite the projected increases in overall economic growth in developing countries, income disparity within these countries is likely to become even greater.

Higher growth in developing countries is also expected to lead to the significant reduction or even near elimination of absolute poverty. However, the underlying poverty line of $1.25/day (in 2005 prices and PPP exchange rates) used for these projections is not sufficiently high to constitute a true departure from poverty. At higher income thresholds, poverty will remain widespread, though significantly less prevalent than today.

A wealthier and more populous world will be the main driver for rising overall food consumption. Feeding a global population of 9.15 billion people in 2050 requires an increase in total food production of some 70% (nearly 100% in the developing countries). Demand for cereals is projected to rise about 50% by 2050 (+1 billion tonnes), up from some 2.1 billion tonnes today. Demand for other food products with higher income responsiveness such as livestock products or vegetable oils is projected to grow well above the rates predicted for cereals. Meat production, for instance, will rise by over 200 million tonnes to 470 million tonnes while soybean production will rise even faster from 215 million tonnes today to 515 million tonnes by 2050. Not included in these estimates is a potentially significant increase in demand from the (bio) energy sector. High energy prices and/or government policies (mandates/subsidies) could create considerable extra demand for agricultural products and ultimately for natural resources such as land, water or genetic resources.

Trade

Differential regional growth rates in demand and supply will be accompanied by changes in agricultural trade flows. The overall volume of food imports to developing countries is expected to more than double (Table 1) to 2050. However, their overall food self-sufficiency ratio will remain unchanged, as their domestic food production is foreseen to rise just as rapidly as their imports (Table 1). Particularly rapid growth is expected for their cereal imports, which are forecast to nearly triple; they would also rise faster than their domestic production, lowering their self-sufficiency ration from 94% in 2004/06 to 90% by 2050 (Table 1). In terms of shipped tonnage, imports are expected to reach nearly 300 million tonnes by 2050, up from about 110 million tonnes in 2004/06.

The averages for developing countries as a whole mask significant regional differences. The Near-East and North Africa region will remain the most import-dependent region, with self-sufficiency falling from 61% in 2004/06 to 56% in 2050. The high and rising imports by many countries of the region reflect both their inability to expand domestic production (land and water scarcity) and at the same time, their ability to pay for higher imports (revenues from oil and gas exports). In effect, the region exports hydrocarbons and imports carbohydrates and will continue to do so over the next four decades. At the other extreme, Latin America and the Caribbean, currently still a significant net importer of cereals, is expected to become self-sufficient overall; many individual countries of the region are even forecast to produce significant exportable surpluses. South and East Asia may see some decline in self-sufficiency, but SSR rates will remain in the range of 80-95% compared with 83-100% at present. At the same time, developing countries' net exports of oilseeds and vegetable oils are projected to triple to some 25 million tonnes (in oil equivalent), and those of sugar could double to some 20 million tonnes by 2050. Again, a growing role for bioenergy has the potential to alter these prospects considerably, as all three commodity groups are used as biofuel feedstocks.

The resource outlook

Growth in agricultural production over the past decades has come largely from higher productivity (80%); higher yields accounted for 70% of incremental production, increased cropping intensity for another 10%. Future growth will even be more productivity driven (+90% of output) while only 10% of incremental production will stem from an expansion of cropland. The projected expansion of cropland for the world as a whole masks considerable differences between regions and between developed and developing countries in particular. While cropland under cultivation will rise by about 120 million hectares (ha) in developing countries, it is expected to shrink by about 50 million ha in developed countries, leaving an overall net addition of some 70 million ha for the world as a whole. Within the developing world, sub-Saharan Africa

Table 1. Net Trade Positions and Self-sufficiency Rates of Developing Countries

	2004/06		2030		2050	
	Net Trade, billion US$*	SSR	Net Trade, billion US$*	SSR	Net Trade, billion US$*	SSR
Cereals	-13.4	0.94	-27.8	0.91	-36.2	0.90
Basic food	-13.6	0.95	-28.3	0.93	-36.6	0.92
non-food	8.1	1.21	10.4	1.17	12.6	1.16
Livestock	-5.3	0.98	-7.7	0.99	-8.3	0.99
Total Food	-15.6	0.98	-33.1	0.98	-36.6	0.98

(-)=net imports, (+)=net exports, *constant US$ (million, ICP)

Source: FAO

and Latin America account for essentially all of the net expansion effect.

Land equipped for irrigation is expected to rise by some 32 million ha (11%), and when this increase is combined with greater cropping intensity, the harvested irrigated land should expand by 17%. Developing countries account for the entire expansion effect. Water withdrawals for irrigation are expected to rise by only 11% (or some 286 cubic km), lower than the rate of expansion of irrigated land (17%). Two factors explain this slower growth of water use. The first is a general improvement in water use efficiency, which is expected for the irrigation of all crops; the second is a projected decline in irrigated rice acreage (the most water-intensive form of crop production), which ultimately reflects a general slow-down in demand growth for rice. The additional demand for water, albeit small overall, adds to existing water scarcity, particularly in many countries of the Near East and North Africa region. Growing water scarcity in this region aggravates the problems that have already arisen from severe land scarcity and constitutes a key factor for the region's high import dependence.

While the contribution of higher yields to future output will continue to rise, the speed of growth is expected to slow, with growth rates well below those attained in the past. This process of decelerating growth has already been underway for some time. For the world as a whole and for most individual regions, it reflects declining population growth and growing satiation levels of food demand; both factors are particularly pronounced in developed countries. Slower demand growth at largely unchanged cropland use translates – for the world as a whole – into reduced overall yield growth. On average, the yield growth for the next 44 years is expected to be about half (0.8%) of what was attained for the past 44 years (1.7%). In absolute terms, average cereal yields would reach some 4.3 tonnes/ha by 2050, up from 3.2 tonnes/ha at present.

Can the additional needs be accommodated within the existing resource base?

Analyses based on the Global Agro-Ecological Zone (GAEZ) database of FAO and the International Institute for Applied Systems Analysis (IIASA) suggest that there are still ample land and productivity reserves to step up crop production in the future. Of the nearly 4.2 billion ha suitable for crop production globally, only 1.6 billion ha are currently in use (Table 2). While this is no doubt a huge untapped cropland reserve, these estimates need to be interpreted carefully and substantially qualified. One such important qualification is that much of the suitable land that is not yet in use is concentrated in a few countries in Latin America and sub-Saharan Africa, where much of it is not accessible to agriculture. In many areas, the basic infrastructure needed to actually crop these land resources are still underdeveloped or entirely missing, and given the high costs of developing these areas, productivity-based growth (higher yields on existing cropland) will be cheaper and thus more likely. At the same time, countries with high and still growing food needs often have already exhausted their land potentials, and in many of these countries, land constraints are compounded by rising water scarcity. As explained, this is particularly true for countries in the Near East and North Africa and is also increasingly true for much of South Asia. Moreover, the notion of suitability as such needs careful definition. Some of the potential land classified as suitable is actually suitable for growing only a few crops or only a single one and these crops are not necessarily those for which demand is currently high or expected to rise in the future. In addition, it is not always easy to overcome the constraints that limit suitability to only a few crops. Where constraints such as soil acidity or endemic pests and diseases circumscribe the suitability for many crops, it can still be technically impossible or economically unviable to lift these constraints. Finally and most importantly, a large part of potentially suitable cropland is currently under forests (at least 800 million ha), in protected areas (200 million ha), or already used as urban settlements (60 million ha). Tapping into these reserves would come at considerable cost to the environment, carbon sinks and biodiversity.

The availability of water resources shows a pattern similar to land availability, i.e. growing local and regional scarcity amid global abundance. Most worrisome are the developments in a band of countries from China, through India and Pakistan, to much of the Near East and North African region where over-pumping of groundwater aquifers has led not only to growing water scarcity for agriculture, but also to acute scarcity of drinking water. Where water is scarce, water quality often is jeopardized as well. Irrigation water return-flows typically carry more salt, nutrients, and minerals than natural water systems and drinking water reservoirs. But water scarcity and water quality problems are not solely of a physical nature. There is also "economic" water scarcity, which reflects low water use efficiency and wasteful use of irrigation water. On average, only 40% of pumped water reaches plants, i.e. 60% is lost through leaking pipes or evaporation in inefficient irrigation systems (flood, sprinkler). Investments in water use efficiency and better policies (water pricing) could help remedy these problems. Where

Table 2. Land Potential, Quality and Actual Land Use

	Total land suitable	Very suitable	Suitable	Moderately suitable	Land in use in 2005/07	Gross land balance
Percent of maximum constraint-free yield	100-80	80-60	60-40	40-20		
million hectares						
World	4188	1348	1509	794	1602	2586
Developing countries	2782	1109	1001	400	966	1816
Sub-Saharan Africa	1031	421	352	156	236	795
Latin America	1066	421	431	133	203	863
East Asia	366	146	119	53	235	131
Near East & North Africa	99	4	22	41	86	13
South Asia	220	116	77	17	206	14
Developed countries	1371	222	495	391	635	736

Source: Bruinsma, 2009

water scarcity is largely of a physical nature, the development of drought-tolerant crops could help. For all forms of scarcity, trade in water-intensive goods, constiuting a shipment of virtual water, can help mitigate local scarcities.

As the largest share of incremental production has and will come from higher productivity, the slow-down in yield growth in many regions and for a growing number of crops has been received with considerable concern. Untapped yield potentials and options to raise yields therefore deserve particular attention. But a close inspection of the reasons behind the slow-down in growth indicates that declining growth rates does not necessarily indicate shrinking yield growth potentials; neither should continuously high yield growth be interpreted as a sign of ample growth potential. It is not sufficient to consider only the declining rates of actual yield growth. Equally important is to examine how the differences between actual yields and yield potential (the so-called bridgeable yield gaps) have evolved. These bridgeable gaps reflect differences in infrastructure, incentives, policies, or management skills in comparable or identical agro-ecological conditions. To the extent that these factors can be transferred from high to low productivity systems, bridgeable yield gaps can be closed without raising the overall yield potentials. Empirical analyses based on the GAEZ data system suggest that bridgeable yield gaps do indeed account for a large part of existing yield differences between regions, and fears that actual yields (e.g. for rice) have reached a plateau seem to be in most cases unwarranted (except in a few very special instances).

Food, Hunger, and Nutrition

Overall, the outlook to 2050 suggests that the global food situation will continue to improve, albeit at a slower pace. The average dietary energy supply is projected to reach 3050 kcal/person/day by 2050 (2970 kcal in the developing countries), up from 2842 kcal in 2005/07 (2724 in developing countries). Increasing food availability together with some improvements in access to food is expected to reduce the prevalence of chronic undernourishment in developing countries from 16.3% (823 million) in 2003/05 to 4.8% in 2050. With populations still growing in many developing countries, some 370 million persons are likely to remain chronically underfed.

Slow progress in reducing hunger amid ample overall resources and large untapped production potentials emphasizes that hunger is above all a poverty problem and not one of limited production potentials or the ability of the world as a whole to produce enough food. Agriculture nonetheless has a pivotal role in reducing hunger and poverty. More than 70% of the poor live in rural areas and many of them rely on agriculture for their livelihoods. They are poor because their agricultural resource

base is too unproductive, used unsustainably or is simply too small. A larger and more productive agriculture sector that uses its resources more sustainably holds the key for them to escape poverty and thus hunger. This in turn requires investments to make agriculture more productive and its production methods more sustainable.

Hunger and Poverty Reduction as Economies Transform

An efficient agricultural sector has been the basis for successful economic transformations in many of today's developed countries. It was the precursor to the industrial revolutions in Europe and the U.S. and more recently to those in China, Taiwan, Korea, Thailand, Vietnam and other rapidly growing Asian economies. During these transformations, investment in agriculture kept real food prices low, helped to produce capital surpluses, and stimulate overall economic growth. Higher overall growth created new employment opportunities and in turn helped absorb the rural labour surplus that emerged from the transformation of agriculture. This transformation was accompanied by a transition away from many small subsistence producers to fewer and larger commercial farmers, leading to convergence towards a new equilibrium with fewer farmers, more non-farm employment, and larger farm operations overall. This process of structural transformation towards larger farms and fewer people in agriculture is expected to continue. Higher agricultural productivity and a growing saturation of food demand will ultimately limit the overall potential of agriculture to contribute to growth and income generation and circumscribe the number of livelihoods that can be sustained by agriculture.

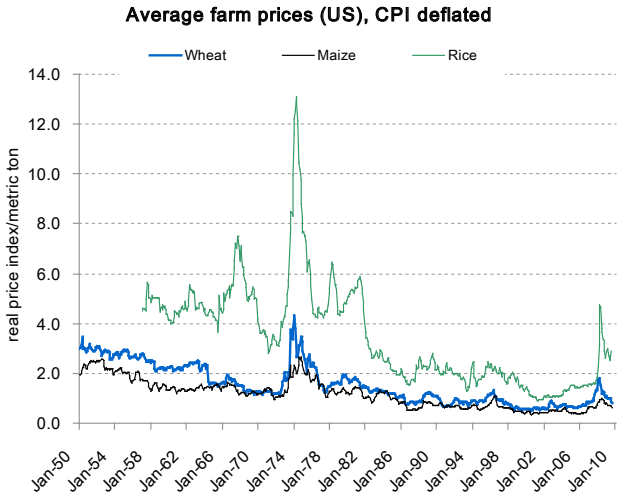
While the role of agriculture as a driver of overall growth will diminish over time along with its share in GDP, the experience of today's middle-income countries suggests that its role in poverty and hunger reduction will still be significant. Agriculture's contribution to hunger reduction consists not just in producing food where needs are most pronounced but also in generating income and supporting rural livelihoods. Poverty reduction requires investments in a number of different areas. These include (i) investments in sectors strongly linked to agricultural productivity growth such as rural infrastructure (roads, ports, power, storage and irrigation systems), (ii) investments in institutions and the broader enabling environment for farmers (research and extension services, land titles and rights, risk management, veterinary and food safety control systems), and (iii) non-agricultural investment to bring about positive impacts on human wellbeing, including social safety nets and cash transfers to the most needy.

Prices and price volatility

Over the past 60 years, real prices for food, i.e. prices adjusted for inflation, experienced a marked decline (Figure 1). For products where longer time series are available, this downward trend can often be extended back for more than 100 years. However, this pace of decline has slowed since the mid 1990s, and if the timeframe of the analysis is limited to the last decade, the downward trend seems to have reversed. The reasons for the long-term decline are well-rehearsed. They include rapid productivity growth in agriculture (higher yielding varieties and breeds, scale effects of larger farmers, improved managerial skills, etc.), a growing satiation of food demand in richer countries, subsidized production and exports of OECD countries, low energy and input prices, and overall, a moderate growth in industrial use of agricultural products. Equally well-rehearsed are the factors that have driven up prices over the last decade and have resulted in a pronounced price hike for many agricultural commodities in 2007/08 (Figure 1). These include: increased production of biofuels from agricultural feedstocks, adverse weather conditions in key producing regions, and low stocks and export restrictions, and different weights are ascribed to these factors.

There are divergent views as to what factors will likely shape the trends and swings in future prices and what relative weight these factors will have. The FAO long-term outlook for global agriculture does not provide price projections to 2030/2050. What is available, however, is a discussion of the underlying factors that are likely to affect future price trends and swings. On the demand side, the outlook suggests a gradual slowdown in the growth of

Figure 1



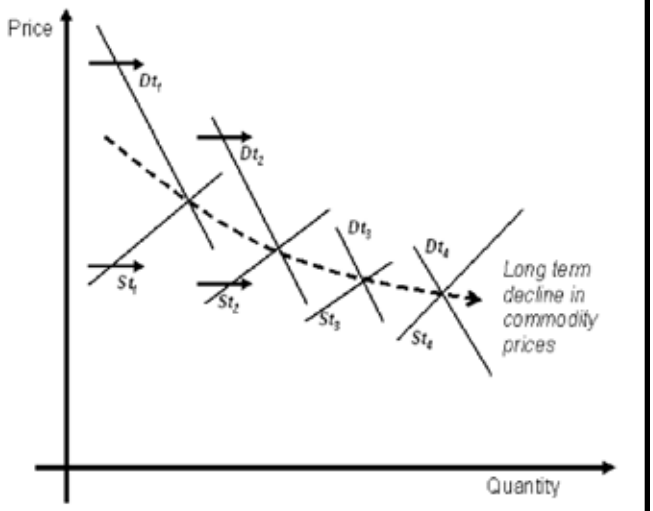
food consumption, brought about by a further slow-down in population growth and a growing satiation of demand. These developments have been underway for some time in developed countries and are, particularly with a view to the very long-run, eventually also expected to put a brake on demand growth in developing countries. Overall, the growth rate of aggregate food demand in developing countries is expected to slow from 1.8% per year between 2005 and 2030 to 0.8% between 2030 and 2050, even though feed demand will continue to rise-driven by a robust growth in demand for livestock products (from 2.2% for 2005/2030 to 2.8% for 2030/2050).

If aggregate demand shifts to the right at a slower pace (Figure 2), upward pressure on prices would have to come from lower productivity growth or constraints in agricultural resources. As far as productivity constraints are concerned, the analysis of untapped productivity potentials (bridgeable yield gaps) suggests that considerable yield growth could still be had, particularly for crop production in developing countries. Likewise, and notwithstanding existing water or land scarcity for many individual countries, land and water constraints are unlikely to curb production and raise costs and thus prices at a global level. More serious constraints could arise from limited physical availability of fertilizers (phosphate) or higher costs of fertilizer production (nitrogen). In general, higher energy prices could lead not only to higher input prices, but also higher costs of production for all commodities.

At sufficiently high levels, energy prices could also lift food prices in a more direct manner. Given the potentially huge demand arising from the energy sector, the energy market could, at high prices, siphon off any additional output produced by agriculture and thus create a minimum price for food. In other words, at the energy price where agricultural feedstocks become competitive for the energy market (i.e. the parity price or breakeven price), the energy market creates perfectly elastic demand and thus a floor price for food and agriculture. This endogenous demand effect would be quite independent of the exogenous demand effect that has been brought about by biofuel mandates and subsidies. It would also be independent of whether the feedstocks used for bioenergy production are food or non-food products (2nd generation). As long as food and bioenergy markets compete for the same resources (land, water), a shift towards non-food feedstocks will not alter the demand effect from the energy market in principle.

Another factor that could significantly affect the longer-term price trajectory for food is the impact of climate

Figure 2



change or, more precisely, a faster shift towards adverse climatic and thus agro-ecological conditions. There appears to be a broad consensus that the impacts of climate change on global agricultural output will remain limited as long as the global mean temperature (GMT) rises by less than 2°C. In most baseline projections, GMT increases beyond this level are expected only after 2050. That said, faster and farther increases could result in stronger and more adverse impacts and leave less time for adaptation to changing agro-ecological conditions, reduce the overall production potential, and result in an upward pressure on food prices. Moreover, faster and stronger climate change could also result in more frequent and more severe weather extremes, a potential trigger for larger price swings. Such swings could become even more pronounced in a world where a large part of demand comes from rich consumers and is increasingly unresponsive (price-inelastic demand) to price changes. Poor consumers in disadvantaged production areas (low latitude developing countries) will be most affected by such a development. They would suffer from an overall deterioration of their agricultural production conditions, would be more significantly and more directly exposed to the impacts of extreme weather, while their low levels of income would make them more vulnerable to such price swings. Needless to say, such a scenario would further compromise the overall food security situation of already food insecure, agriculture-dependent economies.