Some Reflections on the Causes and Effects of the Global Food Crisis

Desirée A.L. Quagliarotti

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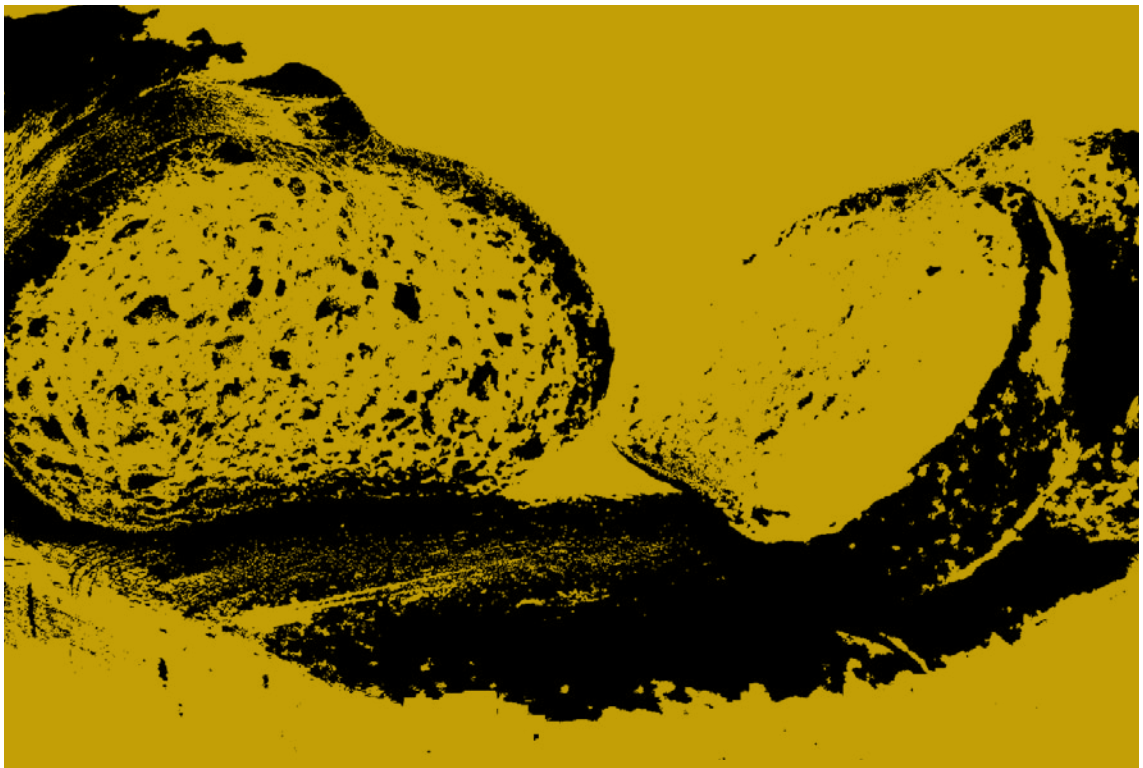
After the global food crisis occurred in 1972-74, prices of food commodities in real terms have declined rapidly and, for about thirty years, the demand of food was met by an available supply at reasonable prices. Since 2006, prices of food commodities have begun to grow, reaching a first peak in 2008 and a second in early 2011. This trend has marked the end of a long period of low level in food prices and opened the era of crisis in the global food system. . This article aims to disclose the nature and underlying causes of the recent food crises focusing on both conjunctural and structural factors; to analyze the socio-economic and geopolitical impacts of food price increases; to identify the possible strategies to minimize the trade-off between the increase of agricultural production and the sustainable use of natural resources.



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After the global food crisis of 1972-74, prices of food commodities in real terms declined rapidly and for about thirty years the demand for food was met at reasonable prices. This justified governments' decisions, both in rich and in least developed countries, to attribute little relevance to investments in agriculture, since importation provided a secure and efficient way to achieve the objective of food security.

Since 2006, prices of food commodities have begun to grow, reaching a first peak in 2008 and a second in early 2011. The onset of this trend marked the end of a long period of low food prices and the beginning of an era of crisis for the global food system.

Several studies have attempted to analyze the underlying causes of these sudden surges in the prices of agricultural commodities, singling out a number of factors acting both on the demand and on the supply side. The end-point analysis of the food crisis was presented during the FAO Conference on Nutrition held in Rome in June 2008, when what could be defined as the officially accepted interpretation at the international level of the underlying reasons behind the crisis was put forward. In particular, the following explanatory variables were identified: the growth of the consumption of food, especially meat, in emerging countries, with the consequent increase in the demand for cereals for animal nutrition; the growth of agrofuel production induced by high fuel prices and the incentive policy launched by the EU and the USA; rising oil prices and the consequent increases in the cost of production factors used in agriculture (fertilizers, pesticides, fuel) and in processing and transportation costs; the tightening of adverse climate-related trends, with negative impacts on production; and the financial market crisis, which encouraged speculation on agricultural commodities. The synergy of all of these factors triggered what experts call a "perfect storm", creating an imbalance in a food system already characterized by an inherent structural weakness making it extremely vulnerable under conditions of economic, ecological and social crisis.

Interpreting the world food crisis

The monthly change in international food prices is measured by the FAO Food Price Index, which consists of the average of five commodity-group price indices (meat, dairy, cereals, oils/fats, sugar) weighted with the average export shares of each of these groups for 2002-2004. After a substantially static period from the 1980s to 2006, since 2007 the FAO Food Price Index has started to show a trend of sharp swings. In particular (Figure 1):

– from March 2007 to June 2008, a first rise in prices occurred and the nominal index increased very rapidly, registering a 63.3% leap;

– from July 2008 to February 2009, a sudden drop in price levels was recorded and the nominal index showed a -35.9% reversal;

– from March 2009 to January 2010, prices started to rise again and the index increased by 25%;

– from February 2010 to July 2010 there was a short period of stability;

– from July 2010 to February 2011, a sharp increase in prices was seen and the index rose by 37.8%;

– from February 2011 to June 2011, the price level dropped slightly, by 1.6%.

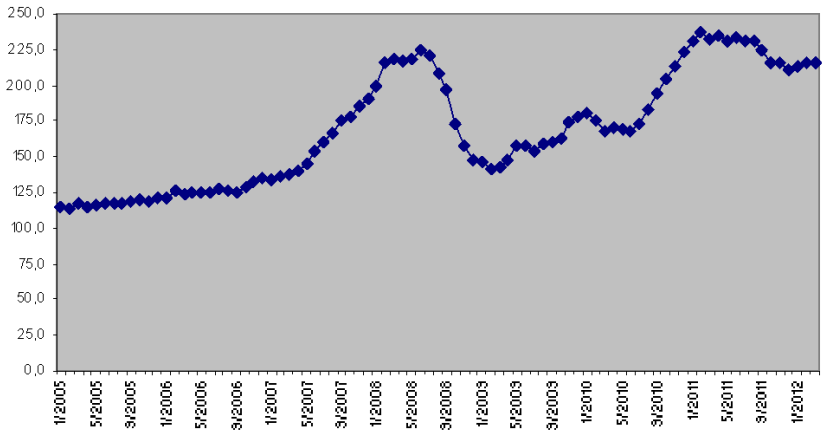
An analysis of these data shows not only a strong increase in food commodity prices, but also a worrying increase in volatility, which creates uncertainty and instability in the market. Markets for food commodities have always been characterized by high volatility, but it is important to note that volatility has reached exceptionally high levels in recent years: considering the standard deviation of prices as a measure of volatility, we observe that over the last 7 years it has more than tripled compared to the previous 16 years (35.8 vs. 11.8) (Figures 2-3).[1]

Since the first price spike in 2008, experts have begun to ask themselves whether these increases are substantially different from similar events in the past, and whether the long-term decline in real prices has come to a halt and we are actually looking at a turnaround. Experts are reflecting on the fact that, even though higher or lower prices are the norm in agricultural markets, high prices usually tend to be shorter-lived than low prices.[2] What sets these new dynamics

[1] In statistical terms, by "rising food prices" one intends increases in the mean of the food price series, and by "food price volatility" the standard deviation or variance of the price series. Standard deviation measures variation or "dispersion" from the average (mean, or expected value). A low standard deviation indicates that the data points tend to be very close to the mean; high standard deviation indicates that the data points are spread out over a large range of values.

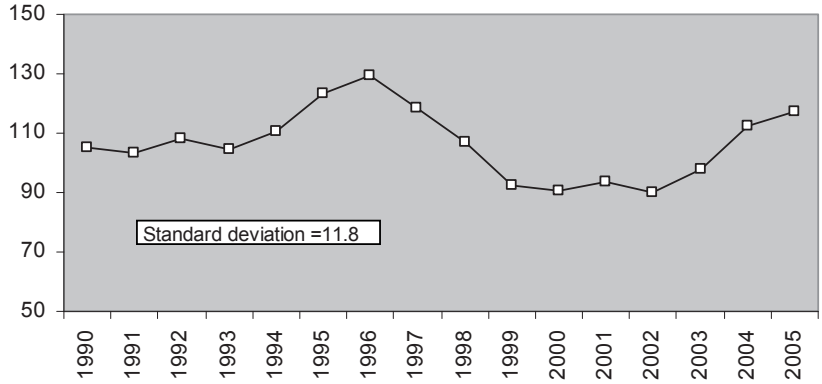
[2] Fao, *The State of Agricultural Commodity Markets 2009. High Food Prices and the Food Crisis: Experiences and Lessons Learned*, Fao, Rome 2009.

Figure 1. Dynamics of food commodity prices (FAO Food Price Index 2005-2013)



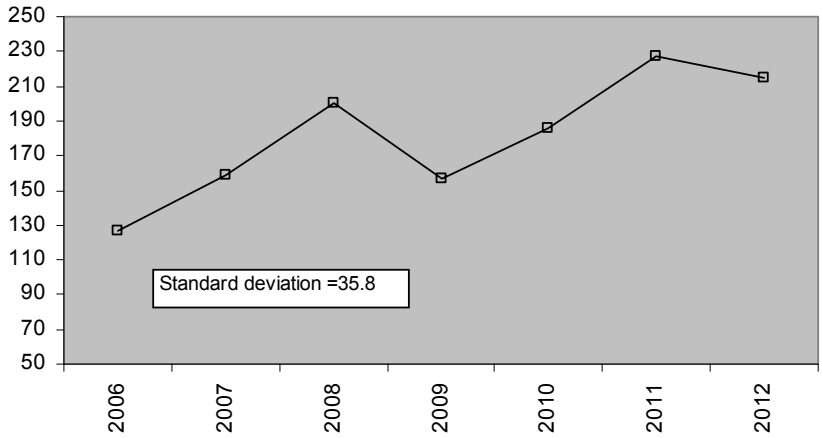
Source: FAO data 2013

Figure 2. FAO Food Price Index 1990-2005 and the standard deviation of prices



Source: FAO data 2012

Figure 3. FAO Food Price Index 2006-2012 and the standard deviation of prices



Source: FAO data 2012

apart is the concomitant increase of the international prices of nearly all main food and feed commodities and the fact that price levels remained high even after the end of the effects of short-term shocks. This was the signal of a structural change in the long-term dynamic of agricultural prices. Experts have begun to identify explanatory variables and their relative weight in terms of contributing to the increase and fluctuation of prices. Many studies have shown that some impact factors had a historical relationship with food prices, while others were linked to the emergence of new phenomena, which, although not directly related to the sector, were indirectly affecting the price setting and supply and demand levels.

The main traditional factors that have acted on both the demand and the supply side are: world production, international grain stocks, price of oil, and population growth.

Production levels can be regarded as the key factor in food price dynamics. Production depends, in its turn, on various factors, including climatic conditions and agricultural technology. The extreme weather

events that have struck the major cereal producing countries over the last few years have played an important role in the determination of international agricultural prices. According to Lobell et al., rising temperatures and rainfall regime changes have led to an increase in cereal prices by 18.9% from 1980 until today.[3] It has been estimated that during this period adverse weather conditions have caused a 3% decline of world cereal production. There is an increasing belief that the frequency of adverse climatic events and their extreme nature are no longer to be regarded as exceptional events, but rather as structural ones depending on climate change. The phenomenon of climate change is perceived as a serious handicap for the future sustainability of agricultural production. The effects of climate change are twofold. On the one hand, rising temperatures in the middle and long run will result in a decline in agricultural productivity and thus contribute to the increase in food commodity prices. On the other, the intensification of adverse weather events causing unpredictable losses of crops will lead to increases in price volatility in the short-run.[4]

The effects of adverse weather events are also amplified by the highly concentrated nature of food markets. In the case of corn and rice, the top five producers contribute over 70% of world production and the top five exporters about 80% of world exports. As to wheat, the top five producers and exporters contribute approximately 50 and 60% respectively of global production and exports. This extremely high concentration limits the world's adaptability to climate shocks. Any adverse weather event leading to a contraction of supply can have a very large distorting effect at the international level, with an immediate impact on global prices and their volatility.[5] Likewise, any policy changes, such as trade bans, customs taxes, or other restrictions on exports, by any of the top exporters will significantly affect the levels and volatility of food prices.

[3] D. Lobell, W. Schlenker, J. Costa-Roberts, "Climate Trends and Global Crop Production Since 1980", in *Science*, 333, 6042, 2011, pp. 616-620.

[4] BCFN, *Food Prices and market Volatility: The Variables Involved,* Codice Edizioni, Torino 2011, pp. 60-61.

[5] BCFN, *The Challenges of Food Security*, Codice Edizioni, Torino 2009.

The total supply of agricultural goods does not depend only on current production, but also on available stocks.[6] The level of stocks of major food commodities can be considered an effective indicator of the supply's capacity to satisfy the current demand and, above all, of the availability of agricultural commodities in the future. Therefore, a good level of cereal stocks plays a damper role in cases of imbalance between supply and demand, mitigating volatility and stabilizing the level of crops prices. Agricultural economists argue that countries generally need to keep a stocks-to-use ratio of around 17-18% in order to guarantee equilibrium on agro-food markets.[7] Figure 4 shows that, since 2000, world stocks of grains have suffered a gradual downward trend, and it is expected that in the future they will stabilize at a lower level due to both structural market changes and changes in climatic conditions.

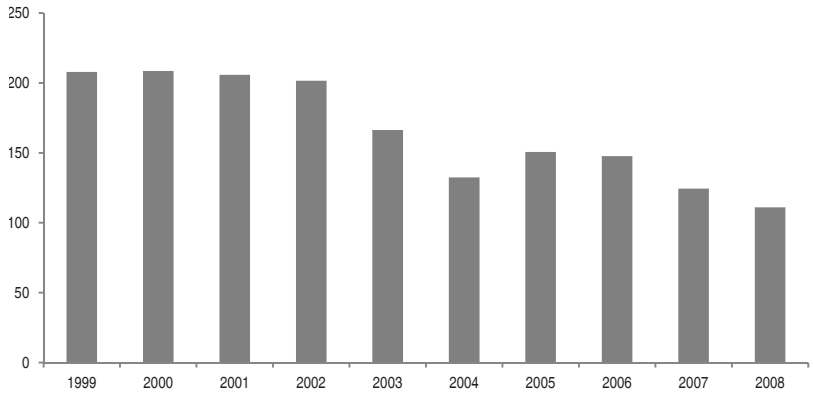
The global level of accumulated stocks can thus be regarded as the second variable traditionally linked to the trend in food commodity prices. There is a statistically significant negative relationship between stocks and price levels. Figure 5 shows the correlation between the stock-to-use ratio and wheat prices between 2000 and 2011. The index shows a strong negative correlation between the two series (-0.73), which suggests the existence of a close relationship between stock levels and price developments.

Another variable historically tied to the price of food and agricultural commodities is the price of oil. Specifically, the influence of this variable is manifested primarily through its effect on agricultural production costs, particularly on the cost of fuel used for machinery, the price of chemical inputs, and the costs of intermediate stages of production and consumption such as transportation and packaging. If we compare the trend in real values of the price of oil with that of agricultural prices, we will observe that since 2002 they have gone

[6] Stocks of food commodities are the share of the crop that is stored instead of being destined for immediate consumption.

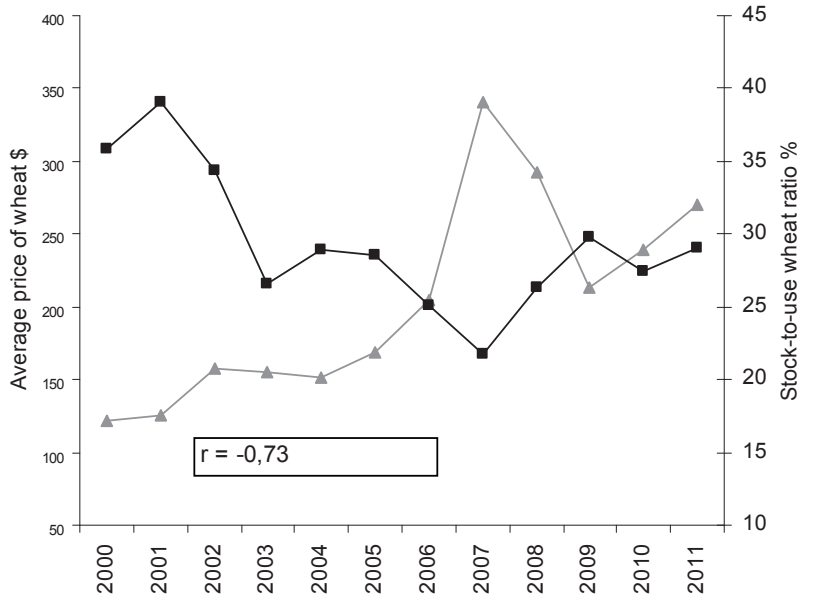
[7] Headey D., Shenggen F., *Reflections on the Global Food Crisis. How did It Happen? How Has It Hurt? And How Can We Prevent the Next One?*, International Food Policy Research Institute (IFPRI), 165, Washington D.C. 2010, p. 31.

Figure 4. World stocks of grain (thousands of tons)



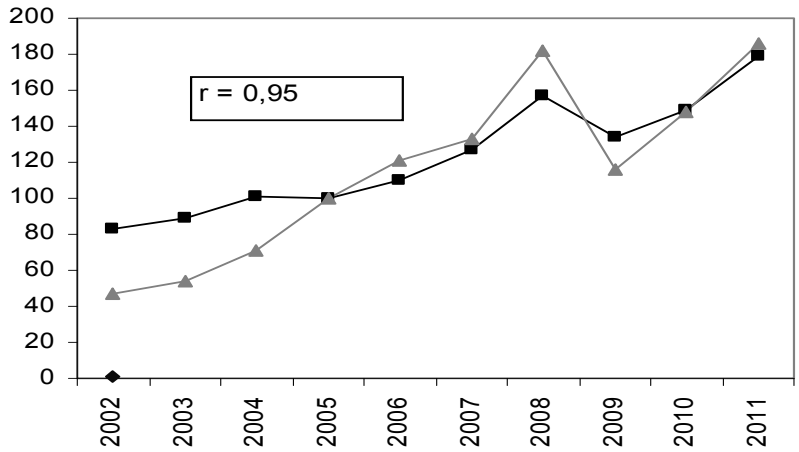
Source: FAO data 2008

Figure 5. Correlation between stock-to-use ratio and wheat prices (2000-2011)



Source: FAO data 2012

Figure 6. Food Price Index and Crude Oil Price Index 2002-2012 (2005=100, prices in US $)



Source: IMF data 2012

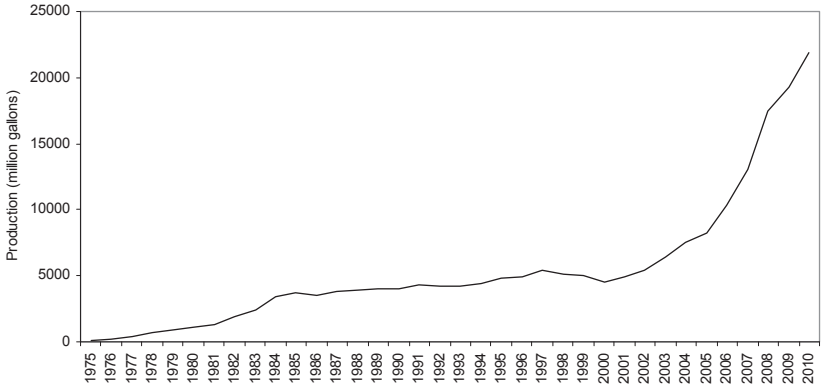
hand in hand (Figure 6), as the high correlation index (r = 0,95) between the two time series bears out.

Finally, another significant factor is demographic dynamics. Population growth and urbanization generate an increase in food demand. According to the FAO, the number of people that need to be fed in the world increases by 60-70 million every year. By 2050, the world population will reach 9.1 billion and food production will increase 70% to meet the growing demand.

Along with the traditional factors acting on the mechanisms of food price formation, in recent years other factors have come into play, which had been absent or relatively insignificant in the past. These factors are essentially three: the increased demand for agricultural products to be used for agro-fuel production; the economic growth of emerging countries such as China and India, which has led to a strong increase in animal protein demand; and the spread of financial speculation on agricultural commodities, mainly powered by sharp declines in the equity and bond markets.

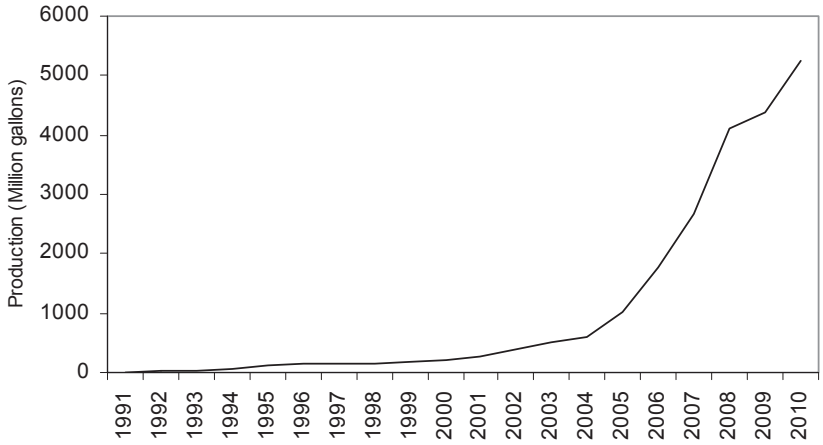
The newest link between oil prices and food prices is agro-fuel

Figure 7. World fuel ethanol production 1975-2010



Source: Earth Policy Institute 2011

Figure 8. World Biodiesel Production 1991-2010



Source: Earth Policy Institute 2011

production. The objective of energy security and the issue of the exhaustion of fossil fuel sources have led to an increased attention to renewable energy, both in Western and in emerging countries. Among sources of "green" energy, the share of production of agro-

fuels has increased rapidly in recent years and is expected to continue to grow in the near future. In particular, in 2007 world production of bioethanol touched 13,090 million gallons and that of biodiesel 2,679 million gallons, accounting together for 1.1% of the total market for liquid fuels. In 2010, world production of ethanol reached 21,926 million gallons and that of biodiesel 5,253 million gallons, more than 2.4% per cent of the total market (Figures 7-8).[8]

This fast growth is closely interconnected with energy policies enacted by many countries to reduce dependence on fossil fuels, increase the use of energy derived from renewable sources, and reduce greenhouse gas emissions. Binding targets aiming to replace a share of fossil fuels with agro-fuels have been adopted in several countries, encouraging large investments in the sector. It is currently estimated that the United States are granting subsidies between 5.5 and 7.3 billion dollars a year to the sector. Even the European Union, with its Directive on Renewable Energy (2009/28/EC), is paving the way for the use of agro-fuels in the European market. The Directive requires member states to achieve, by 2020, a minimum of 20% of energy from renewable sources in total consumption and a of 10% agro-fuels in the transport sector. These systems of constraints and incentives are diverting farmland and crops from food to biofuel production, triggering a food/fuel competition. According to OECD-FAO analyses, in 2020 12% of the global production of raw cereals will be used for the production of ethanol (compared to 11% between 2008 and 2010), and 33% of the sugar production (compared to 21% today). 16% of the global production of vegetable oils will be used to produce biodiesel (compared to 11 percent today).[9] An analysis of the potential effects of the production of agro-fuels cannot be confined to the amount of crops converted into fuel, but must be extended to the amount of land that is destined or converted to the production of energy crops. The growing demand for biofuels worldwide is generating land-use conflicts, as biofuel crop plantations are encroaching on the large areas required for the production of food and feed.[10]

[8] Usda 2010.
[9] OECD-FAO, *Agricultural Outlook 2011-2020*.
[10] G.C. Schoneveld, *Potential Land Use Competition from First-Generation Bio-*

Table 1. Estimated impacts of biofuels on food commodity prices

Organization	Weighting assigned to biofuels (%)
The World Bank	70-75 (Mitchel, 2008)
FAO	10-15 (Fao, 2008)
International Food Policy Research Institute	25-30 (Rosegrant, 2008)
OECD	5-16 (Oecd, 2008)

Several studies by international organizations have examined the link between increases in food commodity prices in 2006-2008 and the expanding biofuel production (Table 1).

These reports estimated that the influence of biofuels on rising food prices ranged from 5 to 75%, depending on the agricultural crop and country being analyzed. Caution should be applied when interpreting and comparing these data, as the methodologies and underlying assumptions of these estimates differ. In general, we can conclude that biofuel expansion contributed to the increase in the prices of agricultural commodities but, given the divergent results of estimates, doubts exist about the weight of biofuels vis-à-vis other factors.[11]

Economic development in emerging countries, especially China and India, poses an enormous challenge to the global food system.[12] The increase of the per capita income of such a large portion of the world's population does not reflect only in an increase in food consumption. It is leading to a gradual change in the composition of the food basket, with a transition from a diet consisting mainly of cereals to a diet rich in meat and dairy products. FAO projections suggest that global meat production and consumption will rise from 233 mil-

fuel Expansion in Developing Countries, Occasional Paper n. 58, CIFOR, Bogor, Indonesia 2010.

[11] C. Charles, *Should We be Concerned about Competition between Food and Fuel? Analysis of biofuel consumption mandates in the European Union and the United States*, Policy Brief, GSI/IISD, Geneva 2012.

[12] According to the IMF, emerging countries are countries that are growing socially and economically and in which there is a process of industrialization. About 28 markets are recognized as emerging, including China and India, which account for 70% of the population of emerging markets.

lion tons in 2000 to 300 million tons in 2020, and milk consumption from 568 to 700 million tons over the same period. With the increasing consumption of animal products, the demand for grain required for livestock nutrition will be growing exponentially, since the conversion factor between meat and grains is greater than 1.[13] Consequently, changes in demand for meat and dairy products will affect the demand and prices of the crops needed for livestock breeding. According to OECD and FAO projections, in the 2011-2020 decade prices of cereal feed will be 30% higher than in the past decade.[14]

The third and last phenomenon likely to affect agricultural markets is the financial speculation that has dominated the world economy in recent years. The liberalization of financial markets launched by the U.S and Great Britain in the '90s has paved the way for a "financialization" of agricultural markets. Since 1800, commodity exchanges had the function of protecting buyers and sellers of agricultural commodities from short-term price volatility and thus was a form of risk hedging. Their transformation into derivatives has led to a true market speculation on food, where several actors, although not belonging to the agricultural sector, may buy or sell financial products within the agricultural market. The Chicago Board of Trade is the symbol of the increasingly close relationship between nutrition and finance. Here the prices of agricultural commodities are established and, currently, any speculator can sell or buy cereals in the form of derivatives. When the sub-prime mortgage crisis hit in 2007, financial speculators removed trillions of dollars from equities and mortgage bonds, and invested part of this sum in food and raw materials, generating a significant increase in the share of futures and options bought and sold by private operators and funds. In the 2005-2008 period, recorded transactions involving agricultural commodities for "non-commercial" purposes doubled. The new players are not directly involved in the agro-food sector. They operate in the market following a logic of profit maximization that

[13] To produce 1 kg of chicken, it takes about 2 kg of grain; for 1 kg of pork, about 4 kg of grain; and for 1 kg of beef, between 7 and 8 kg of grain.

[14] Fao, *Food Outlook: Global Market Analysis*, Fao, Rome 2011.

is only concerned with the price of agricultural products. Although it has not been demonstrated empirically that financial speculation has distorted market prices of raw materials, the increase of investments flows on agricultural products has coincided with the increase in food commodity prices. Moreover, as we have learned from economic theory, speculation acts more on the speed than on the causes of rising prices, and thereby amplifies volatility and instability.

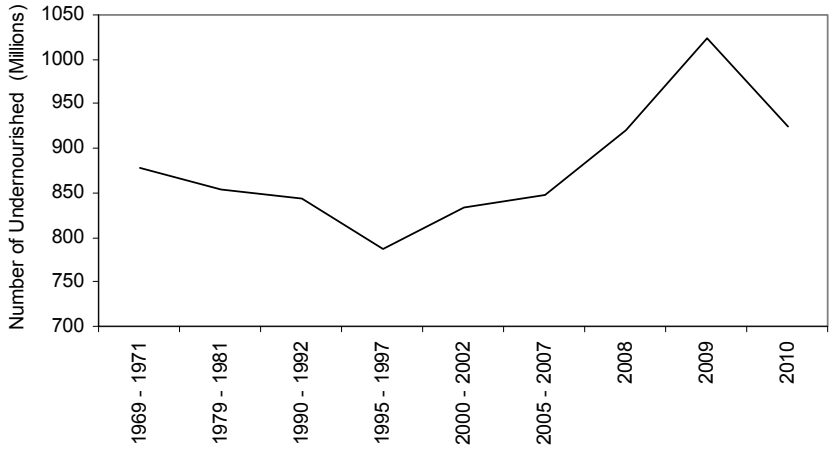
Each of these five factors, taken individually, would not be able to generate such a broad and sudden instability and increase of agro-food prices. Only their synergy and the consequent generation of multiplier effects can account for the causes of a food crisis as severe as that experienced in recent years.

The socio-economic and geopolitical impacts of the global food crisis

The impact of the increase and volatility of the prices of agricultural commodities can be viewed from two different perspectives, one socio-economic, the other geopolitical. As food prices increase, the purchasing power of the poor declines, the composition of their diet worsens, and their food consumption decreases. These changes directly affect the United Nations *Millennium Development Goal* 1 targets for poverty, full and productive employment, and hunger. At the macroeconomic level, the countries most at risk are developing countries whose food imports carry a significant weight in their balances of payments. According to the FAO, the 2007-2008 food crisis plunged 75-80 million people into hunger and food insecurity. In 2009, the people in conditions of chronic hunger were 1,023 million (Figure 9).

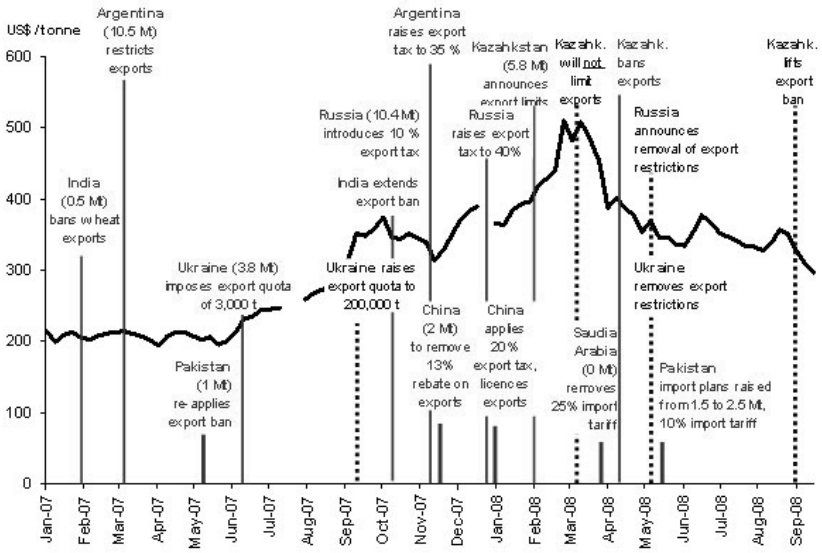
The global food crisis has consolidated a pessimistic view of the ability of the agro-food system to meet the nutritional needs of a growing population, especially in a context of scarcity of natural resources, continuous fluctuations in the prices of agricultural commodities, and close interrelationships between markets. This new awareness has forced countries to strengthen their level of intervention in the agro-food sector in order to protect their national interest, using economic policy instruments which have actually am-

Figure 9. Undernourishment in the world 1969-2010



Source: Earth Policy Institute data 2011

Figure 10. International trade policies and the Fao Cereal Price Index (January 2007 and September 2008)



Source: M. Lagi, K.Z. Bertrand, Y. Bar-Yam, *Food Crises and Political Instability in North Africa and the Middle East*, New England Complex System Institute, Cambridge, Usa 2011.

plified the current negative effects, with important social and economic consequences. More than forty governments have imposed price controls and restrictions on exports. In particular, exporting countries have reduced and in some cases prohibited exports of agricultural commodities to keep prices stable on the internal market. Conversely, importing countries have reduced duties or increased subsidies in order to encourage imports. These policies, designed to generate benefits at the national level, have had a distorting effect at the international level, amplifying the imbalance between food demand and supply, and increasing world prices.

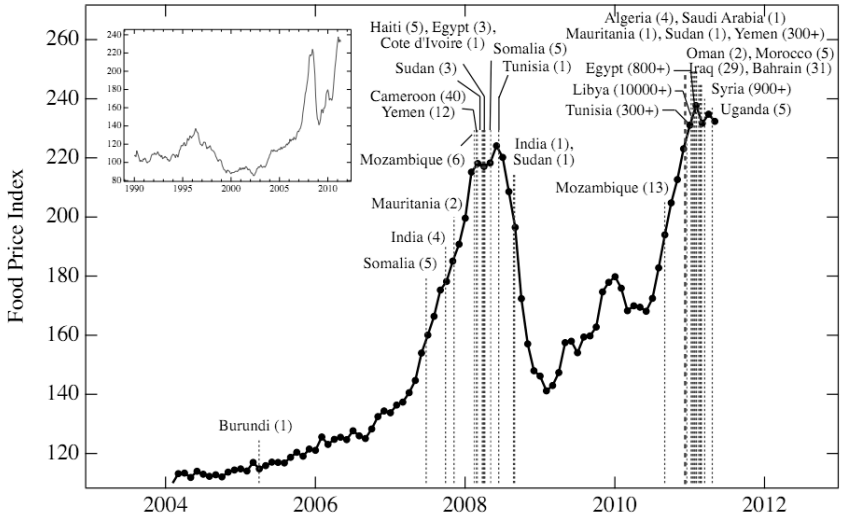
To illustrate the relationship between the adoption of certain trade policies and price evolutions, Figure 10 shows the trend of the Cereal Price Index and the main trade measures adopted by importer and exporter countries.

While import policies have led to a general increase in the demand for food commodities, export policies have further reduced the global supply. Both have increased the volatility and level of food prices.

Simultaneously with the recent food crises, riots broke out in many African and Asian countries.[15] Particularly, between the end of 2010 and the early of 2011, the phenomenon known as the "Arab Spring" manifested itself all over the Middle East and North Africa in the form of violent uprisings. Although the causes underlying this widespread malcontent are numerous, it is undeniable that the rise in prices of agricultural commodities has played a role in triggering the riots. Although the degree of correlation between the uprisings and food prices is something to be left to geopolitics experts to assess, it is noteworthy that the countries most affected by riots show some common features, viz., a scarcity of strategic natural resources - such as arable land and water – which limits agricultural production, and high levels of per-capita food imports, standing between 25 and 30% of total domestic consumption. In order to identify a potential link between food price

[15] Throughout history, food-related social unrest has been frequent. Food riots are thought to have helped bring about the French Revolution, the fall of the Confederate States of America, the Russian Revolution, and the fall of the British Raj in India (M.F. Bellemare, *Rising Food Prices,Food Price Volatility, and Social Unrest*, Social Science Research Network, 2012).

Figure 11. Major riots with numbers of victims and performance of the FAO Food Price Index (January 2004- January 2011)



Source: M. Lagi, K.Z. Bertrand, Y. Bar-Yam, *Food Crises and Political Instability in North Africa and the Middle East*, New England Complex System Institute, Cambridge, Usa 2011.

increases and the outbreak of protests, Figure 11 shows the trend of the FAO Food Price Index and the timing of food riots in recent years. In 2008, more than 60 food riots erupted worldwide in thirty different countries. After a short period of stability, a new surge of price spikes occurred between the end of 2010 and the beginning of 2011. The graph shows a temporal overlap between price levels and riots. These observations are consistent with the hypothesis that higher global food prices are an important explanatory variable for social unrest.[16]

The considerable difficulties many countries are encountering in

[16] M. Lagi, K.Z. Bertrand, Y. Bar-Yam, *The Food Crises and Political Instability in North Africa and the Middle East*, New England Complex Systems Institute, Cambridge, USA 2011.

securing a constant flow of food imports at stable prices are forcing some of them to outsource agricultural production, buying or leasing large plots of arable land abroad. This practice, called by its critics "land grabbing", is spreading exponentially. It is mainly adopted by capital-rich countries lacking enough natural resources – primarily fertile land and water – for food self-sufficiency. Their aim is to achieve national food security by reducing their dependence on agro-food international markets. FAO Director Jacques Diouf identified land grabs as a modern form of colonialism that threatens the food sovereignty of poorer countries for the benefit of emerging economies and agribusiness corporations. The scenario that is emerging could have serious geopolitical consequences as millions of hectares of fertile land are transferred from countries with high rates of undernourished people to a limited group of states. Because of the secrecy that characterizes most of the signed agreements, the lack of involvement of local communities, and the unfavorable conditions accepted by governments in the host countries in the hope of attracting more foreign capital, these land transfers threaten to jeopardize the future of least developed countries. Because of its political, economic, and social implications, the acquisition of land cannot be regarded as an investment as any other. Local communities are deeply tied to their land. Land is not a mere commodity. It is a source of life imbued with social and cultural values that cannot be quantified or expressed in merely economic terms. And food that is produced on these lands is a fundamental right recognized by the United Nations.

Looking at the food crisis to understand what lies beyond

Experts have linked the recent food crises to several factors, but their findings tell only part of the story. What emerges from a deeper analysis is the extreme vulnerability of the global agro-food system, due to a series of structural factors having a no longer recent historical origin.[17]

Before the Industrial Revolution, humans were more conscious

[17] P. Bevilacqua, *Miseria dello sviluppo*, Laterza, Roma 2008.

of environmental constraints. Their culture, values, knowledge, technology, and social organization were by necessity closely adapted to nature. Most agricultural systems were based on small-scale *subsistence* farms and consequently each family had a variety of farm animals and different crops capable of satisfying basic food needs. Agricultural techniques were well adapted to local environmental conditions and the prevalent agroecosystem was *polyculture*, a mixture of several crops growing together in the same field. This type of agriculture offered several advantages. The abundance and variety of plants protected the soil from rainfall, reducing erosion. Crop residues provided large amounts of organic fertilizer, and the use of leguminous plants in crop rotation and intercropping provided several soil quality benefits due to these plants' natural capability to fix atmospheric nitrogen. Polyculture was also a natural insurance against pest attacks, diseases and bad weather.

Agriculture began to change in Europe when the Industrial Revolution made it possible to replace human and animal labor with machines allowing farmers to cultivate larger tracts of land. This opportunity triggered many other transformations. With the increase in farm sizes, farmers were able to produce more than they needed to feed themselves, allowing the transition from subsistence agriculture to a market economy. Food surpluses allowed the supplying of cities. Many people left the countryside and moved into urban areas, where economic opportunities were better. From an agroecosystem point of view, the main change was the replacement of mixed farming with monoculture, since that single-crop fields are more suited to mechanized agriculture. This substitution was also encouraged by the market economy, because producing a single crop was more cost-effective for farmers. However, as monoculture was not as effective as polyculture in protecting the soil from erosion or maintaining its fertility, risks of crop failure due to bad weather or pest attacks increased. Consequently, farmers were forced to make agriculture less reliant on the aleas of the external environment, an objective they achieved by using irrigation water and chemical fertilizers and pesticides. Technology, machines and fossil fuels gave humans the illusion of being set free from natural constraints and the unpredictability

of weather hazards. Henceforth agriculture has been seen more in economic terms, as a business enterprise, and less in environmental terms, as a gift of nature. Everyone started to believe that the future was going to provide such a progress in science and technology that it would have opened up endless possibilities for economic growth.

The transformations of agricultural and food systems were even more evident from the 1960s onwards. According to Eric Holt-Giménez and many other scholars, economic development policies driven by northern countries (Green Revolution, Structural Adjustment Programs, Word Trade Organization, and the agricultural subsidy systems of the USA and EU) must be regarded as the real causes of the weakness of the current global agro-food model, having led to the destruction of food production systems based on diversity around the world.

The period from the 1960s to the 1990s witnessed the so-called Green Revolution, promoted by various international organizations and agricultural research centers. Theoretically, the objective was to defeat hunger by modernizing the agriculture sectors of less developed countries. Early experiments in Mexico and south-east Asia achieved impressive results in terms of agricultural productivity, but these increases in crop yield did not reduce malnutrition in these areas. Furthermore, in the long-run the Green Revolution showed several negative side-effects. Its "technology package", constituted by high-yielding varieties of seeds, machinery, chemical fertilizers and pesticides, and large-scale irrigation schemes, caused the loss of 90% of agro-biodiversity, reduced water availability, increased salinization and soil erosion, displaced millions of peasants from rural areas to city slums, dismantled traditional agricultural systems which had guaranteed food self-sufficiency, and increased the power of agribusiness corporations in the market chain.

In the 1980 and 90s, the application in southern countries of Structural Adjustment Programs (SAPs), implemented by the World Bank and the International Monetary Fund with the goal of reducing these countries' foreign debt, aggravated the already difficult living conditions of local populations. SAPs implemented "free-market" policies to help these developing countries' economies to become more market-oriented. These programs included both internal (privatization and deregulation) and external measures (reduction of trade barriers).

The governments of developing countries were forced to abolish subsidies to commodities such as bread, rice, milk and sugar, and decrease public spending on education, health, housing and infrastructures. Devaluation of the national currency was enforced in order to make products more competitive on international markets, but this measure reduced the purchasing power of local economies. At the same time, interest rates were increased to attract foreign capital through high rates of remuneration. As regards external measures, the programs stimulated exports to accumulate foreign currency reserves, increased monocultures of cash-crops, and reduced agricultural varieties for local consumption. Customs barriers were dismantled, facilitating the imports of highly subsidized products coming from the United States and Europe. These policies had a direct impact on agricultural production and food security, leaving these countries at the mercy of the market and the interests of transnational corporations.

The World Trade Organization (WTO), established in 1995, consolidated this process by launching international treaties binding national laws to its goals. The *General Agreement on Trade and Tariffs* (GATT), the *General Agreement on Trade and Services* (GATS), and the *Agreement on Trade-Related Aspects of Intellectual Property Rights* (TRIPS) strengthened the control of developed countries over the economies of the South of the world. These "development" policies imposed by international institutions have contributed to the disappearance of local and traditional agricultural production systems, and their replacement by intensive industrial food production. As a main consequence, southern countries, which until forty years ago were self-sufficient and even had agricultural surpluses amounting to billions of dollars, today have become fully dependent on the international market, importing an average of $11,000 million in food annually.

Industrialization of agriculture, top-down agricultural research, and neoliberal policies have led to the spread of intensive farming systems based on genetically uniform crops and livestock breeds more vulnerable to pests and diseases. Dependence on relatively few plant varieties has significantly undermined agrobiodiversity.[18] Today, less

[18] Agricultural biodiversity, also known as agrobiodiversity, is the variety of genetic

than 3% of the 250,000 plant varieties available to agriculture are being grown and half of the breeds of many domestic animals have become extinct. Intensification and specialization are also affecting the landscape, homogenizing it and destroying its traditional elements. Loss of forests, coastal wetlands and wild uncultivated areas is exacerbating the genetic erosion of biodiversity.

It is not just agrobiodiversity and traditional agricultural systems, but also traditional knowledge that is being lost. Over the years, farmers' daily observations have made them true scientists in the field, capable of ensuring the conservation of the habitat, the soil, and water systems. All around the world, farmers' knowledge has preserved biodiversity and enhanced food security for their own communities. Farmers have succeeded in modifying, improving and spreading crops, adapting them to the diversity of climates and soils. They have selected different crops and different varieties within crops, with a strong emphasis on adaptation over time and site specificity. In doing so, farmers have accumulated an immense wealth of shared knowledge that "science" has almost entirely ignored.[19] In fact, reductionist scientific knowledge downplays traditional knowledge for its lack of systematic analysis, verification, innovation and dynamic evolution, and associates it with stagnation and backwardness. On the strength of this prejudice, scientific knowledge has progressively displaced traditional knowledge, which has nevertheless survived for centuries as part of evolving knowledge systems closely linked with ecosystems and characterized by a high adaptive capacity.

resources available for food and agriculture. It is the result both of natural selection and of careful selection by farmers, herders and fishers over millennia. It is a vital branch of biodiversity, comprising the diversity of genetic resources (varieties, breeds, and species) used for food, fodder, fiber, fuel and medicament. It also includes the diversity of non-harvested species that support agricultural production (soil micro-organisms, predators, pollinators), and those in the wider environment that support agro-ecosystems (agricultural, pastoral, forest and aquatic) (FAO definition, 1996).

[19] International Commission on the Future of Food and Agriculture, *Manifesto on the Future of Knowledge Systems. Knowledge Sovereignty for a Healthy Planet*, Regione Toscana /ARSIA, Florence 2009.

Conclusions

What emerges from the above analysis of the causes and effects of the global food crisis is an extremely complex picture. Many factors have contributed to create the current imbalance in the international food market, and the continuous spikes and volatility in the prices of agricultural commodities are having significant negative impacts, both geopolitical and socio-economic.

According to Lester Brown, the ability to produce food is increasingly becoming a strategic variable. A new "geopolitics of food" is emerging, which is affecting the balance of power among countries.

Food prices increases affect, above all, that part of the world population still living in poverty and under-nutrition. But today the food security issue does not regard only poor countries. In a context of strong instability of agricultural prices, the loss of trust in international markets increases the perception of vulnerability of food-importing countries. The strategy of achieving the objective of food self-sufficiency does not appear as a rational choice in areas where fertile land and water are scarce. Consequently, many countries have started to consider land acquisition abroad as the most effective option to satisfy the domestic food demand. At the same time, developing countries are seeking to attract foreign investors to cultivate their land surplus and make up for their shortages of capital and infrastructure. Both of these factors are encouraging land-grabbing, leading to a paradoxical process in terms of food security, where poor countries with high percentages of undernourished people are giving away their fertile land to developed countries so that the latter can produce food to export back home.

Recent food crises are bringing out the awareness that we are entering a new era of scarcity. We are presently in a transition from a time when food was abundant, although iniquitously distributed, to a time of scarcity, where the gap between the demand and supply of food is gradually widening. Several structural factors have triggered this shift. The worldwide spread of an industrial agricultural model completely incompatible with the socio-economic and environmental context of developing countries has led to a decrease of these countries' food self-sufficiency, a shift to less heterogeneous and

nutrient-rich diets, the increase of malnutrition, the erosion of agro-biodiversity, the disappearance of traditional agricultural and knowledge systems, the abandonment of rural areas, and the deterioration of natural resources. SAPs and the globalization process launched by the WTO have exacerbated these impacts, making the less developed economies increasingly dependent on international markets.

But what is distinguishing even further these global food crises is not only the existence of long-term structural causes, but also the greater impact of conjunctural factors (e.g., extreme weather events) due, on the one hand, to their higher frequency, on the other, to a closer economic integration resulting in more rapid transmission of shocks from one market to another.

According to the FAO, to feed the 9 billion people that will populate the Earth in 2050 agricultural production will have to increase by 70%. To achieve this goal, the food system will have to face many challenges. In addition to population growth, the demand for agricultural commodities will increase because of the greater purchasing power of emerging countries and the use of agricultural crops to produce agrofuels. Moreover, the increase in food production will have to be brought about in a context of natural resource scarcity and a deeper impact of climate change.

Over the last 50 years, input-intensive farming methods and mechanization have rapidly increased agricultural productivity. The world's agricultural production has grown between 2.5 and 3 times over this period, while the overall cultivated area has grown by only 12%. In too many places, however, this performance has been achieved through management practices that have degraded the land and water systems upon which the production depends**.** In some of these areas, the accumulation of environmental impacts in key land and water systems has now reached the point where both production and livelihoods are compromised. At the same time, climate change is bringing additional risks due to warming and related aridity, shifts in rainfall patterns, and the frequency and duration of extreme events.

The increase of agricultural production necessary to meet the global demand for food can be brought about in two ways: by expanding arable land, or by increasing of its productivity. Today, on a

global area of 13.2 billion ha, 12% is already in use for cultivation, 28% is under forest, and 35% comprises grasslands and woodland ecosystems. Worldwide, land suitable for cropping is about 4.4 billion ha, including areas with protected status. Thus, there is a large amount of currently uncultivated land that could theoretically be brought into production. However, much of this land generally has a low food potential or is covered by forests.

If the increase of arable land is not the more efficient strategic choice, the only option is to increase yields. But even in this case there are constraints. The dream of the Green Revolution is now past its apogee, as shown by the decrease of the annual percentage yield (which has dropped from 3% in 1960 to 1.5% in 2000). This result can be ascribed to two types of limitations: on the one hand, environmental deterioration, which has had a negative impact on agricultural production; on the other, the reaching of a technological frontier that can be improved on only marginally in the near future.

How can we overcome these obstacles and minimize the trade-off between the increase of agricultural production and the sustainable use of natural resources? The awareness that agriculture is at a crossroads already emerged in 2002, when the World Bank and the FAO launched the *International Assessment of Agricultural Knowledge* (IAASTD), whose objective was to assess the impacts of past, present and future *agricultural knowledge, science and technology* (AKST) on the reduction of hunger and poverty, improvement of rural livelihoods and human health, and equitable and socially, environmentally and economically sustainable development. About 400 experts selected from around the world drew up five Reports containing 22 core statements, which formulate "options for action" for decision-makers in the framework of strategies designed to improve sustainable food production to alleviate hunger and poverty. These statements include focusing on smallholder farmers, adapting agricultural practices to local social, cultural, economic and environmental ecosystems, and taking into account the triple bottom line of economic, ecological and social impacts summarized in the concept of multifunctional agriculture.[20]

[20] In IAASDT, the concept of multifunctionality recognizes agriculture as a

A concept that has been developed in recent years is that of "agricultural sustainable intensification", which FAO summarizes with the slogan "Save and Grow". In order to grow, agriculture must learn to save, and it can do so through a more efficient use of nutrients, water, energy, and biological resources. This concept is based on an ecosystem approach relying on nature's contribution to crop growth – organic matter in the soil, water flow regulation, pollination and natural predation of pests – with the application of appropriate external inputs at the right time and in the right amount. When agroecological principles are adopted, yield enhancement and stability of production are achieved, as well as several ecological services such as increase of agrobiodiversity, soil and water conservation, and improved biological pest control. This approach rethinks the role of AKST and diversifies it according to differences in agroecological, social and cultural conditions around the world. This heterogeneity can be achieved, both in industrial and developing countries, by promoting farm systems practicing ecological agriculture, preserving the livelihoods of peasants, and producing healthy, safe and culturally diverse foods. This does not mean downplaying the role of science and technology in the improvement of agriculture, but only that the only way to feed the world population in the future will be to emphasize diversity in all its forms: diversity in crops, genetic resources, landscapes, cultural features, and agricultural and knowledge systems; in one word, agrobiodiversity. The future of whole populations depends on the solution of the issues of food insecurity. This structural problem requires the adoption of knowledge-intensive approaches in which science, technology and traditional knowledge complement each other in order to preserve the natural and cultural heritage. When the problem to be solved is hunger it is not possible to rely solely on market rules, because the "Invisible Hand", by its nature, is insensitive to the common good.

multi-output activity producing not only commodities (food, feed, fibers, agrofuels, medicinal products and ornamentals), but also non-commodity outputs such as environmental services, landscape amenities and cultural heritages (IIASTD, *Executive Summary of the Synthesis Report*, Island Press, Washington D.C. 2009).