Sustainability Team Discussion Paper

Food Scarcity - Trends, Challenges, Solutions

May 2010

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Money does not perform. People do.

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Food Scarcity - Trends, Challenges, Solutions

Executive Summary

Food scarcity is set to define food production in the coming decades, putting food security issues at the top of the global agenda. The demand for food is growing, due in particular to two factors: population and income growth. However, supply growth is likely to lag, because of, for example, slowing agricultural yields, limited land availability and the increasing demand for biofuels, all of which leads to competition for available land. Also, in recent months, the phenomenon of land-grabbing – the buying-up of agricultural land by foreign investors – has intensified, and this is likely to exacerbate supply concerns.

It is clear that, if there is to be enough food to feed the growing population, agricultural production has to increase. Consumption patterns also need to change: the reduction of meat intake, for example, is to be encouraged. These political and social issues can lead to business opportunities in the domain of fertilisers, biotechnology and irrigation. In parallel, conventional intensive farming methods, which can cause environmental damage, should motivate the move towards more sustainable agricultural systems.

While the concept of 'sustainable agriculture' can be viewed from a number of perspectives, there is consensus that it should represent an agricultural system which, productive and efficient, also safeguards the environment. While there is no single solution to ensure food security in a sustainable manner, a combination of sustainable farming practices has to be employed to increase food supplies while at the same time protecting the natural resources on which they depend.

The aim of this paper is thus to identify the drivers behind the issue of food scarcity, illustrate previous and potential conflicts, examine current actions being taken to address the issue and highlight opportunities for companies involved in increasing agricultural productivity. Finally, the question of sustainable agriculture as a way of improving intensive agricultural production[1] will be addressed.

Food Scarcity - Trends, Challenges, Solutions

1. What exactly is food scarcity? Defining food scarcity

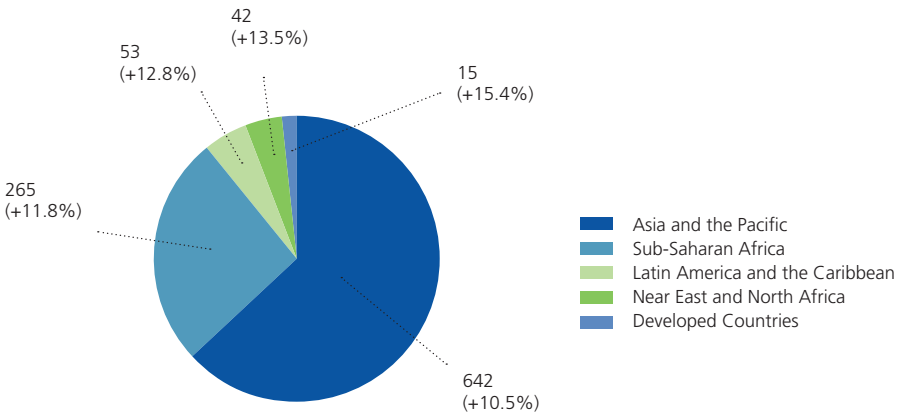
- The world's population is set to almost double between now and 2050, which will inevitably place considerable pressure on food supplies. Concurrently, more affluent societies and the shift towards increased meat consumption are placing increased stress on agricultural production
- The ability to supply food is being hampered by a number of factors. Current agricultural land is facing degradation (due to industrial pollution) and, therefore, decreased yields. Potential farmland for expanding agricultural production is increasingly being restricted due to competing land uses such as biofuel production, urbanisation and, in the longer term, climate change. The inefficiency of agricultural distribution systems is further compounding the supply-side issues

1.1 Is there enough food?

The FAO estimates that there are more hungry people in the world now than at any time since 1970. This situation is likely to intensify between now and 2050, as demand-supply imbalances are expected to increase

According to the Food and Agricultural Organisation (FAO), in the world today more than one billion out of 6.5 billion people are affected by hunger.[2] It is further stated by the International Food Policy Research Institute's (IFPRI) Global Hunger Index that 33 countries have "alarming" or "extremely alarming" levels of hunger.[3] This situation is likely to be exacerbated as, between now and 2050, the global population is expected to increase by 40%, while associated global food production needs are expected to expand by more than 70% as a result of a rapidly growing middle-class demographic in developing countries. Overall, this translates into a larger demand for food.

Figure 1.: Estimated regional distribution of hunger in 2009 (in millions) and increase from 2008 levels (as a %)
(Source: Food and Agriculture Organisation of the United Nations/FAO, 2009)



Next to population growth, the global food situation is being redefined by other driving forces, such as rising incomes, limited land availability, high energy prices, inefficient food distribution systems and climate change, which are all impacting food demand and supply to varying degrees.

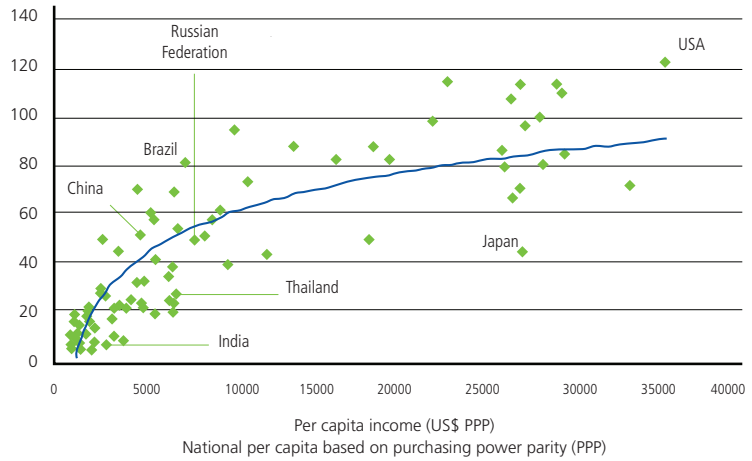
1.2 Why is food demand increasing?

The world population is expected to increase by more than 2 billion people, to reach a total of over 9 billion in 2050

A correlation between rising incomes, increasing consumption of food per capita as well as higher meat intake are key drivers to the projected population growth

According to the UN, the global ***population***, growing by about 75 million every year, ***has increased*** nearly fourfold in the past 100 years, is projected to reach 9.2 billion by 2050. The largest population increases are projected to occur in Asia (particularly in China, India and Southeast Asia), which is expected to account for approximately 60% of the world's population by 2050. Population growth is also projected to occur mostly in urban areas; by 2030, 60% of the world's population is expected to live in urban areas, compared to current levels of 50%. Alongside growing populations, the ***rising incomes*** of a large proportion of the world's population also needs to be recognised. As populations become more affluent, the consumption of food per capita increases, as does the uptake in global calorie consumption per capita. This is also correlated with higher meat intake. Global ***meat consumption*** is expected to grow by 2% annually until 2015, especially in the developing countries, where eating meat is seen as a sign of wealth and prosperity.

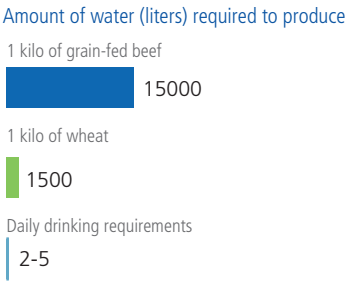
Figure 2.: The relationship between meat consumption and per capita income in 2002
(Source: Food and Agriculture Organisation of the United Nations/FAO, 2006; World Bank, 2006)



Concurrently, it should be realised that meat production is particularly demanding in terms of energy, cereal and water requirements. With nearly half the world's cereal production used to produce animal feed, the growth of meat consumption has a major influence on global food demand; meat consumption is projected to increase from 37.4 kg/person/year in 2000 to over 52 kg/person/year by 2050. Consequently, cereal requirements for more intensive meat production may increase substantially to more than 50% of total cereal production.

What is needed to produce 1 kg of meat?
To produce 1 kilogram of grain-fed beef, it takes, on average, 10 kg of grain and 15000 litres of water. Pigs require about 4 kg of grain to produce 1 kg of pork and chickens require 2 kg of grain to produce 1 kg of meat.

Source: Steve Hall (Originally published in the April/May 1997 issue of Canada EarthSaver)



1.3 Is food supply slowing down?

A number of factors have also been identified that directly result in decreased future food availability/ supply: limited land availability, the growth of agriculture-based biofuels (which compete with the land used for food crops), inefficient food distribution systems and the potential impact of climate change on agriculture.

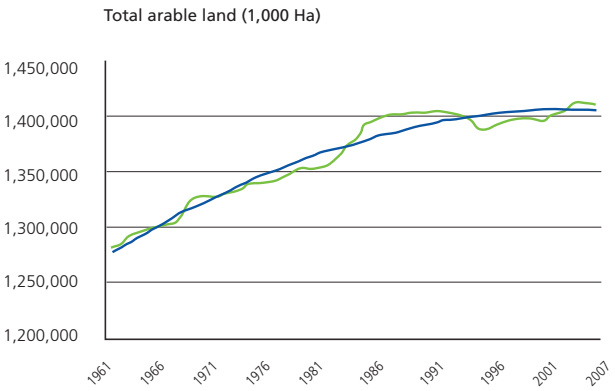
Most usable land has already been cultivated, resulting in a slowing growth in agricultural yields

Agricultural land use is already at capacity. Current land-use data shows that 75.5% of the world's available land area is already being used for agricultural production. The remaining 24.5% is either of very low productivity or comprises areas of high conservation value. The lack of additional available farmland has resulted in a slowing growth in food production yields on a global scale. FAO data reveals that, over the past 47 years, world cereal yields have grown by 1.9%. However, over the past 20 years, the growth rate has slowed to just 1.4%. In Europe, for instance, the annual food production growth rate has fallen to 0.3% over the past five years compared with 1.9% between 1960 and 1999.[4]

Other factors such as land degradation and urbanisation are causing available agricultural land to diminish at an even faster rate

The largest barriers to increasing agricultural productivity worldwide have been identified as soil quality, the length of the growing season and rainfall. Moreover, other factors, such as land degradation (caused by inappropriate farming techniques and industrial pollution) and urbanisation (towns and cities are often developed on former farmland and forests) are causing available agricultural land to diminish at an even faster rate.[5] Estimates have shown that, in the next three decades, the share of urban residents in China's population could rise from 47% to 75%, which would require the clearance of additional rural land for residential housing, roads and other infrastructure.

Figure 3.: Trends in total global arable cropland area between 1961 and 2007
(Source: Food and Agriculture Organisation of the United Nations/FAO, 2009)

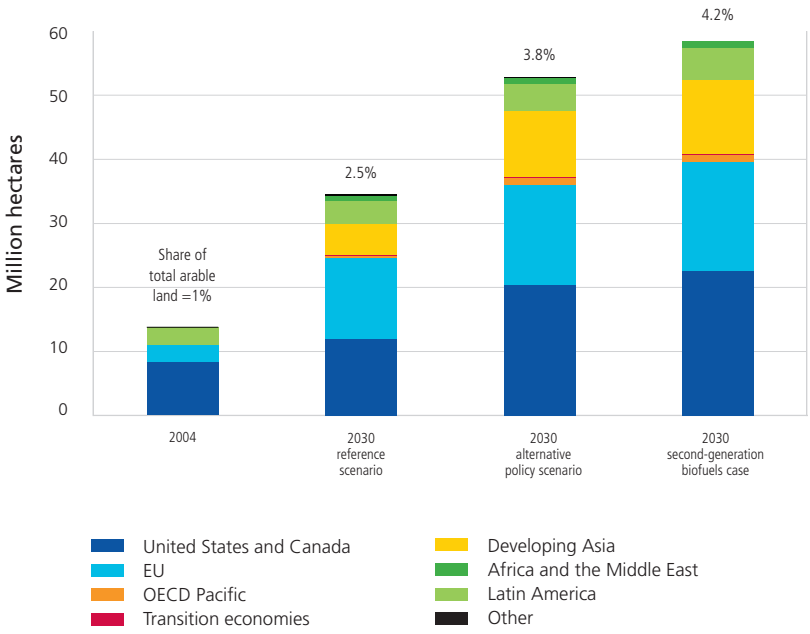


While first-generation biofuels, primarily made from food crops, represent a substitute for non-renewable energy sources, they compete with agriculture for ever-diminishing land resources

Heightened environmental concerns, including the need to tackle climate change, as well as spikes/ peaks in oil prices, have prompted renewed interest in the production and consumption of biofuels. First-generation ***biofuels*** (bioethanol and biodiesel) represent a substitute for non-renewable energy sources and are primarily made from food crops, including corn, wheat, sugar beet and sugar cane for bioethanol, rapeseed, soya beans and palm oil for biodiesel. The US market has substantially increased its focus on corn-based ethanol in the past five years (30% of US corn production is used for ethanol production), while the European market has turned its attention to biodiesel (9% of total arable area). Proactive policies and government support in terms of financial incentives to biofuel producers can create inefficient production processes resulting in fewer crops for food and higher food prices.

Biofuels, for instance, were estimated by the IMF to have been responsible for 20-30% of the global food price spike in 2008, when 125 million tonnes of cereals were diverted from food to biofuel production. To satisfy the global future bioethanol demand, cereal production would have to rise by 30% over the period 2007-2010 and then by a further 10% over the period 2010-2016.[6] This would divert significant amounts of crops away from food production. Second-generation biofuels that do not compete for food (as they are made from biomass feedstock (leaves, straw, woodchips)) do not yet represent a viable alternative to first-generation biofuels, as the large-scale production costs involved are prohibitive.

Figure 4.: Current and projected land requirements for biofuel production in the main producing countries (under three different policy scenarios)
(Source: IEA, 2006)



Export controls such as bans, quotas and taxes are becoming common and are likely to distort food markets both in the short and long term

The agricultural trade has also witnessed increasingly ***inefficient distribution systems***. Driven primarily by rising food prices, the use of various export controls such as bans, quotas and taxes has become evident in recent years. Export restraints can raise the international price in the short term all the while reducing domestic prices, thus distorting food markets and undermining efficiency, both in the short and in the long term. If one exporter restricts exports, other exporters face stronger incentives to also impose export restrictions, creating a vicious circle. Rice is the perfect illustration of this. As only 6% to 7% of global rice production is traded internationally (due to export restraints by major exporters such as Egypt and India), the international price is sensitive to small disruptions in supply. In the longer term, export controls decrease confidence in the reliability of imports, hence increasing pressures for more locally-grown food. If domestic producers are less efficient than exporters, the total food supply decreases.[7]

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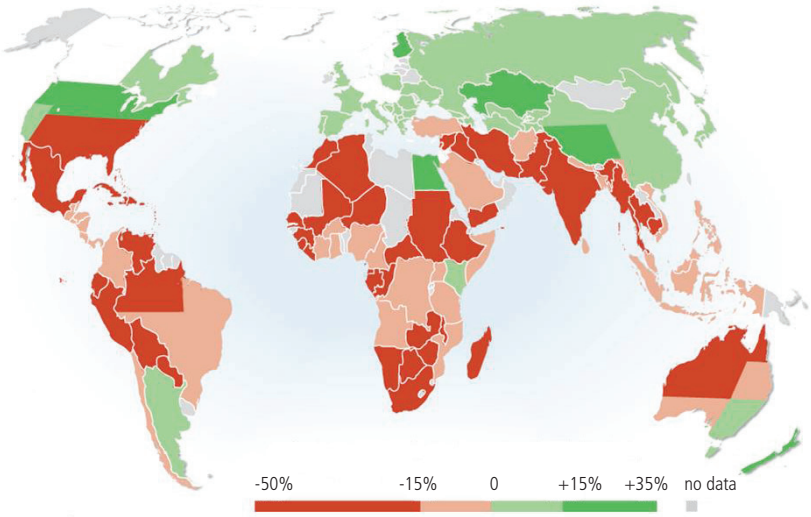
Climate change has the potential to affect the volume, quality and stability of food production; an average 2°C rise in temperature could reduce global cereal production by 5%

According to the Stern report, an average 2°C rise in temperatures could reduce global cereal production by 5%.[8] ***Climate change*** therefore has the potential to affect the volume, quality and stability of food production. Agricultural activities depend directly on climatic factors and access to natural resources, since heat, sunlight and water are the main sources of input for crop growth. The range of adverse events, including reduced freshwater availability and more frequent extreme weather events, will considerably increase the risks for more efficient crop production and livestock management. Climate change is also likely to affect soil quality by depleting organic matter – a major contributor to soil fertility. In extreme cases, the degradation of the agricultural ecosystems could mean desertification, resulting in a total loss of the productive capacity of the land in question. Following the 2009 Australian and Californian droughts, Mexico is currently facing one of its worst droughts in 70 years. Almost 40% of the farmland inspected by the government has been affected by the drought, causing shortfalls in harvests of corn, beans, wheat and sorghum.

Figure 5.: Projected changes in agriculture in 2080 due to climate change
(Source: World Resources Institute, 2007)



Projected changes in agricultural productivity 2080 due to climate change, incorporating the effects of carbon fertilization

As a result of a number of supply-side factors, crop yields are diminishing while the demand for food is increasing. Hence, less food to feed demand is expected in the coming decades.

2. Global impact of food scarcity

- In recent years, decreased food availability has resulted in an increase in global food price inflation, exacerbating malnutrition across developing countries
- In a bid to ensure the security of food supplies, significant environmental stresses are being placed on agricultural ecosystems. The impact of widespread deforestation and excessive water extraction are a growing cause for concern

2.1 Rising cost of food

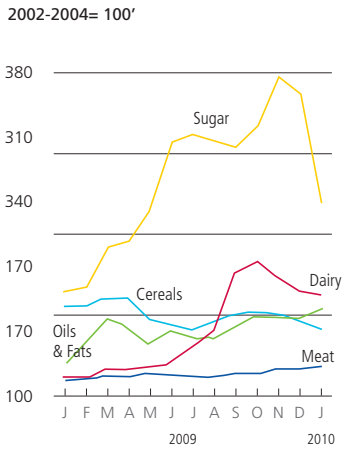
Increasing food scarcity is impacting global food prices, which have been rising since 2000 (peaking in 2008) and are expected to remain high for another ten years. Consequently, the less affordable food drives even more people into hunger and malnutrition. In parallel, higher food prices increase the incentive to use land for food crops, contributing to growing competition for land and water resources.

World food prices are experiencing their sharpest rise for 30 years and forecasts for the next ten years predict continuing high prices

World food prices are experiencing their sharpest rise in 30 years, with surges of 45% since the end of 2006, peaking in June 2008.[9] These ***food-price spikes*** occurred, and have been intensified, due to a combination of factors, including the poor weather conditions which have affected crop yields[10], the shift by farmers to growing feedstocks for first-generation biofuels and speculation by commodity traders – factors unlikely to dissipate in the foreseeable future. Projections for the next ten years reveal that the average prices of agricultural commodities will stay at least at the levels of the previous decade. Cereal prices are projected to be 10-20% higher in real terms relative to 1997-2006, while, for vegetable oils, real prices are expected to rise by at least 30%.[11] The developing countries have been the hardest hit by this cyclical rise in food prices. According to the FAO, "*Food price inflation hits the poor hardest, as the share of food in their total expenditures (60-80%) is much higher than that of wealthier populations (10-20%)*". A recent report by the Fairtrade Foundation revealed that farmers' families in Uganda, Malawi, Nicaragua, India, Sri Lanka and the Caribbean are spending up to 80% of their entire household budget on basic food items, which is seriously impacting their livelihoods.[12]

Food price inflation is significant for lower income households

Figure 6.: FAO food commodity price indices
(Source: Food and Agriculture Organisation of the United Nations/FAO, 2010)



2.2 Hunger is on the increase

The number of malnourished in the world rose to over 1 billion in 2009

During 2007 alone, around 50 million more people were added to the world's 'hungry' due to a combination of rising food prices and decreased food availability. "Hunger" is understood to comprise malnutrition, famine and starvation.[13] As reported in June 2009[14], the number of malnourished in the world rose to over 1 billion, up from 915 million in 2008. The World Health Organisation (WHO) cites malnutrition as the gravest single threat to the world's public health and the biggest contributor to child mortality in the world.[15] Countries with the most alarming ***hunger status*** are predominantly located in sub-Saharan Africa – where one in three persons suffer from chronic hunger – in addition to South Asia, which hosts the greatest number of malnourished people (300 million).[16] In most cases, areas of famine are often associated with areas of armed conflict, the latter often the consequence of food scarcity. The FAO has estimated that conflictcost Africa over USD 120 billion worth of agricultural production during the last third of the 20th century.[17]

Figure 7.: Learning from the past: number of undernourished in the world, 1969-1971 to 2009 (Source: Food and Agriculture Organisation of the United Nations/FAO, 2009)

To end malnutrition, the FAO estimates that agriculture in the developing countries needs USD 44 billion a year in investment: this is double the amount the G8 pledged to invest in agricultural development.

2.3 Environmental stress is growing

The highest rates of tropical deforestation, used to convert existing forests into crop or grazing land, currently occurs in Brazil and Indonesia

The drive to increase food supplies has resulted in attempts to increase agricultural land availability. When this is not properly planned and implemented, negative environmental repercussions can be seen, such as the ***deforestation*** used to convert existing forests into cropland. The two largest areas of notable deforestation are Indonesia for palm oil cultivation and Brazil for cattle grazing as well as the production of feed crops for cattle. Deforestation presents multiple societal and environmental problems. The immediate and long-term consequences of global deforestation are resulting in a loss of biodiversity and climatic disruption. In Indonesia, for example, concerns relating to palm oil are centred on the fact that palm-oil expansion involves the reduction in carbon stocks because of the land-use change caused by the expansion, directly or indirectly, into forests and peatlands. The Indonesian Oil Palm Research Institute (IOPRI) estimates that two-thirds of all currently productive oil palm plantations are involved in deforestation, while UNEP recognises that oil palm plantations are now the leading cause of rainforest destruction in Indonesia.[18]

Pressure on water resources are resulting from increased meat consumption as well as the unsustainable use of irrigation technologies and overzealous use of fertilisers and pesticides

The need to increase food production is also placing pressure on ***water resources***. Changing dietary patterns, such as the increasing consumption of meat products, leads to a higher demand for animal feed and, consequently, water. Bovine meat production, for example, requires 8-10 times more water input than cereal production.[19] And, while irrigation is a crucial part of the food production cycle – as it has the potential to increase land productivity significantly – the imprudent use of water for irrigation can significantly deplete water tables and aquifers. Agricultural chemicals, used to increase crop yields, control weeds and pests, and to prevent diseases to crops and livestock, can also adversely affect water resources: up to 70% of the fertiliser applied to crops can be lost, instead of being absorbed by the crops, resulting in the pollution of groundwater sources as well as rivers, lakes and coastal zones. It has been documented that water tables are falling in scores of countries (including China, the US and India) due to the widespread over-extraction of water for farming activities. This can lead to the chronic scarcity of clean, safe drinking water for increasing numbers of people.[20]

As intensive farming, involving the regular use of technologies such as pesticides and chemical fertilisers, can cause and exacerbate water stress and aggravate food scarcity, more sustainable agricultural practices are needed.

Figure 8.: World water withdrawals and consumption
(Source: World Water Council)

Sector	Water withdrawals	Water consumption
Agriculture	66%	93%
Industry	20%	4%
Domestic use	10%	3%
Evaporation from reservoirs	4%	-

Water withdrawals refer to water diverted from streams/rivers and pumped from groundwater aquifers for human use, but not necessarily consumed. Part of the withdrawn water is returned after use. The quantity that is not reused or left in nature represents **consumed water**, namely water that has evaporated or been incorporated into products and organisms, so that it becomes temporarily unavailable to the other users.

3. Current actions to reduce pressures on food supplies

- While governments are starting to invest in increasing agricultural productivity, other government and corporate actions (land-grabbing and panic buying) are potentially counterproductive
- Certain stakeholders also advocate changing consumer food-consumption patterns

3.1 Investments & policies

Notable agricultural investments have been seen at national level, however agricultural reform in developed countries is necessary to improve global agricultural productivity

The FAO has called upon governments to pay urgent attention to the needs of agriculture and to increase investment in agricultural practices. For instance, as a response to the 2007-2008 food-price peak, the World Bank[21] and many developed countries have increased investments in developing countries' farming by 50%. The most tangible investments comprise improvements in current technology such as drip irrigation, no-till farming, better fertilisers and even the use of genetically modified (GM) crops in order to ***increase agricultural productivity***. Investment in second-generation biofuels produced from cellulose and biomass, which do not compete with food production, are also slowly taking off.

However, these investments will prove futile if farmers' access to markets is not dramatically improved. Policymakers need to examine options and implement measures including spreading price information and building grain stores.[22] Furthermore, in order to increase developing countries' capacity to compete in the global food market, the agricultural systems in the EU and the US will have to be reformed. The EU has reduced the intervention price for butter and eliminated its applied tariffs on cereals[23], but not its bound tariffs[24]. In response to the latter, the US has not taken any steps to lessen the support given to its domestic farmers.

Currently, it remains unclear whether public efforts to improve farmers' access to markets have been demonstrably successful and it will certainly take time to effectively implement such measures on a global scale.

Figure 9.: Investment in agriculture is soaring
(Source: The Economist, 2009)

Country	Examples
The Philippines	Set up a seed bank to improve the quality of seeds and create reserves to be used when crops are ruined by typhoons
Lesotho and Uganda	Created "seed fairs" to increase the seed variety on offer
Tanzania and Mali	Subsidised grain and fertiliser merchants
Nepal and Jamaica	Offered cheap irrigation kits
Malawi	Continued with the fertiliser subsidy
Brazil	Expanded a safety net for family farmers ($800 worth of food sold to the government each year)
India	Extended to every rural district its National Rural Employment Guarantee Act
Burkina Faso, Burundi and Gambia	Created grain reserves to smooth out local price fluctuations

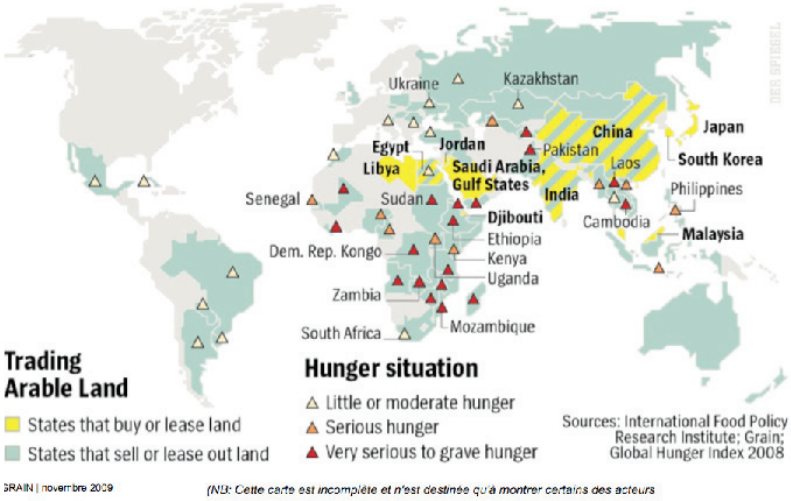
3.2 The race to food and land reserves

At the same time, a growing distrust of the market's current ability to satisfy food demand is resulting in governments and companies looking to secure farmland overseas in order to supplement their domestic production and supplies.

A number of governments and private companies are buying overseas farmland to supplement domestic supplies

The issue of ***land grabbing***, where food importers buy vast tracts of farmland in developing countries, grow the crops there and export them back for their own domestic use, is viewed as controversial. One of the immediate consequences is decreased food security in the developing countries, as local populations are deprived of access to productive resources.[25] According to the UN, 74 million acres of farmland in the developing world were acquired in such deals during the first half of 2009 – an amount equal to half of Europe's total farmland. Examples include sizeable land acquisitions by investor countries as well as companies, particularly in the Persian Gulf and East Asia. South Korea's Daewoo Logistics leased vast areas of productive agricultural land in Madagascar and elsewhere in order to satisfy domestic demand for maize and palm oil. As a consequence, Madagascar suffered political conflicts and witnessed the overthrow of its government in 2009.[26]

Figure 10.: Trading arable land
(Source : Grain, 2009)



Food self-sufficiency can come at the expense of a developing country's domestic production, which risks losing access to and control over its land

Panic buying is another consequence of distrust in the world markets, which has seen a number of governments buy significant amounts of food reserves.[27] For example, when the world's two largest rice exporters, Thailand and Vietnam, banned exports, the Philippines, the world's largest importer, decided that the international grain trade could no longer be trusted to supply its needs and secured the bulk of its 2009 import requirements by buying 1.5 million tons (equivalent to 5% of the total annual trade in the grain) from Vietnam in a government-to-government transaction.

At present, such actions are not viable long-term solutions as both practices could ultimately distort the markets. Recognising that these practices are unsustainable, organisations such as the FAO and the European Commission are developing guidelines to ensure practices that are both sustainable and beneficial to local economies.[28] For agricultural production to be as efficient as possible, trust in the world food markets needs to be restored.

3.3 Changing consumption patterns

Advocating lower meat diets could reduce stress on agricultural systems, while providing multiple benefits for environmental and human health

The manufacture of meat products requires far more feedstock than the production of legumes, grain products, fruit or vegetables. Hence changes in dietary habits towards more animal-derived foods play a role in global food price increases and contribute to negative environmental impacts such as enhanced GHG emissions, deforestation, farmland degradation and the depletion of water resources. Reducing meat consumption could be a viable part of the solution to food scarcity that any individual could adopt. Furthermore, it encompasses multiple benefits for the world's health (such as the reduced incidence of cardiovascular disease, of some forms of cancer, and of animal-borne infections). Recent studies have shown that reducing meat consumption could not only yield significant environmental and human health benefits, but would also still be in line with intermediate crop-yield forecasts and would not require massive land-use change. For example, shifting to a global lower meat diet (defined as 30% of protein from animal products per day compared to 44% in high meat diets)[30] could free up one million square kilometres of cropland and 27 million square kilometres of pasture.[31]

4. Opportunities for businesses

- A number of existing technologies – including irrigation technology, biotechnology as well as the use of fertilisers and pesticides – can be utilised to increase agricultural productivity
- While the improper use of these technologies can have a negative environmental impact, these can, if properly managed and used, represent sustainable solutions to food scarcity

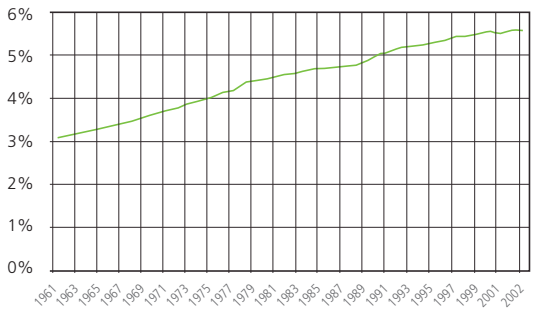
The private sector can play a key role in stabilising food prices and tackling the issue of food scarcity by providing technological advances for increasing the food supply and offering the necessary infrastructure for increased productivity. Opportunities for businesses along the whole food-value chain can be identified. Presently, businesses involved in increasing ***agricultural productivity*** are a logical starting point.

4.1 Agricultural technologies

Efficient irrigation technology can improve crop yields by 10-30%

Irrigation providers can raise agricultural productivity through the use of efficient irrigation technology to ***increase the total irrigated area***. Efficient irrigation technology can improve crop yields by 10-30% over crops grown without irrigation. According to the FAO, only 5.6% of the world's agricultural land is irrigated and much of this irrigation is deemed to be highly inefficient: on average, less than half the water actually reaches the crop. Presently, the bulk of the unrealised irrigation potential lies in the developing markets. Maximising the irrigation potential in such markets implies doubling the current irrigated area. **Jain Irrigation**[32] is one of the major listed irrigation providers that could clearly benefit from this opportunity. As a manufacturer of drip and sprinkler irrigation systems and components, which is advocated by the International Commission on Irrigation and Drainage (ICID) as the most efficient prevailing technique in irrigation, the company expects to maintain a growth rate of as high as 40% from its irrigation business over the next 2-3 years.

Figure 11.: Percentage of arable land that is irrigated
(Source: Food and Agriculture Organisation of the United Nations/FAO)

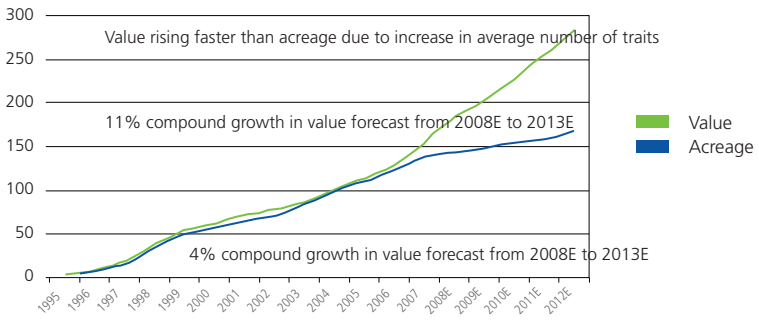


4.2 Genetic Technology

Crops can be modified for increased agricultural productivity...

The need for increased yields and more efficient food production is apparent in the case of ***GM foods***[33]. GM advocates argue that GM foods have the potential to solve many of the world's hunger and malnutrition problems, and can also help protect and preserve the environment through increasing yields. Thus biotechnology can increase agricultural productivity by, inter alia, enhancing the efficiency of the photosynthetic process in plants, increasing resistance to pests, raising drought tolerance and promoting stronger root systems. A recent study revealed that, by 2015, more than 40 countries will be commercially growing biotech crops, compared to 22 countries in 2006.[34] The long-term growth potential of GM seeds is expected to remain substantially intact, with corn as the key growth driver. The increase in GM seeds should be in the region of 11% until 2013. This is mainly driven by: more and more South American countries now relying on GM soybeans and corn; the expansion in the average number of traits in corn; and the development of second-generation herbicide-tolerant soybeans. Currently, 16 companies have regulatory approvals for 141 different GM crops.[35]
The overwhelming majority of these companies are large chemical, pharmaceutical and biotech companies such as **Monsanto**[36], **DuPont**[37] and **Syngenta**[38]. Competitive pressures should grow over the medium term with new products from Syngenta (corn), DuPont (corn) and Monsanto (soybeans), developed to increase yields by 7-11%.

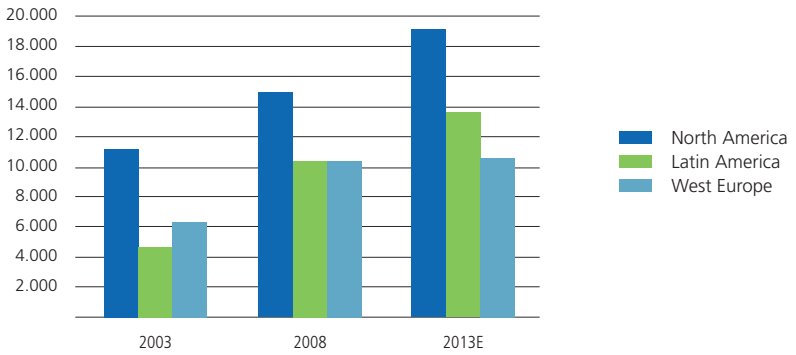
Figure 12.: Expansion in value of GM market and GM acreage (2004 = 100)



...but significant anti-GM sentiment in specific markets over unresolved concerns over human health and wider environmental impacts persists

However, opponents of GM, which comprise a wide range of stakeholders including environmental activists, religious organisations, public interest groups, scientists and government officials, have raised concerns about GM foods, criticising the agribusiness for pursuing profit without concern for potential hazards. They argue that GM foods can negatively impact human health. For example, new genes that are put in food could be resistant to certain antibiotics, therefore reducing the effectiveness of the latter. Moreover, these groups are also concerned about the wider environmental impact of GM foods. Issues of concern include: the capability of the GMO to escape and the subsequent introduction of the engineered genes into wild populations; the susceptibility of non-target organisms (e.g., insects which are not pests) to the gene product; the stability of the gene; the reduction in the spectrum of other plants, including loss of biodiversity; and the increasing use of chemicals in agriculture. In Europe, especially, there has been a strong anti-GM sentiment, supported by negative media attention, which advocates that biotechnology brings "more disadvantages than advantages"[39]. Finally, the UN and the World Bank recently issued their first scientific assessment of world agriculture, which concluded that GM crops have very little potential to alleviate hunger and solve the food crisis,[40] while another study revealed that, at present, none of the GM crops on the market have been modified for increased yield potential.[41]

Figure 13.: Development of the Crop Science Market by Region ($ in Millions)
(Source: Citigroup, 2009)



4.3 Fertilisers & pesticides

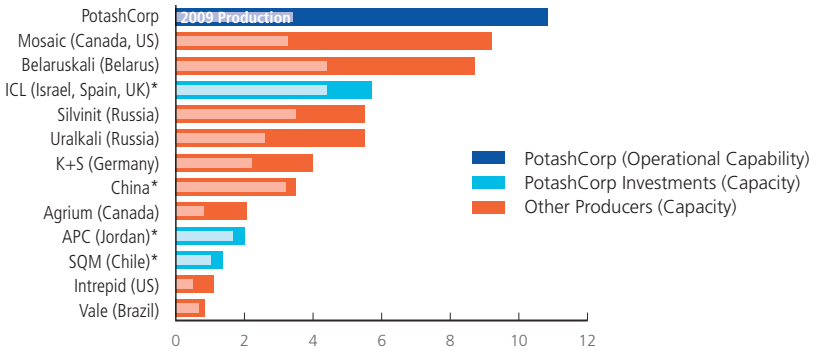
Fertiliser and pesticide use has been widely promoted over the last four decades

Opportunities in the field of agricultural productivity also arise for farm chemical suppliers. Chemical farming, involving the use of ***fertilisers***[42] and ***pesticides***[43] to increase agricultural output, has been promoted during the past four decades to sustain food production. Pesticides and fertiliser use varies greatly from one region to another: the FAO suggests that they tend to be underused in Africa and parts of the Caribbean and Central America but over-used everywhere else. Although it is widely acknowledged that all pesticides have the potential to be harmful to humans and the environment,[44] a high growth potential is estimated for chemical farming. This is due to higher grain prices, that tend to lead to higher famers' income and therefore to an increase in the value of crop chemicals.[45]

The most important agricultural fertilisers are nitrogen, phosphate and potash, the so-called N-P-K fertilisers, which are used in varying proportions in most agricultural production. For instance, **Potash Corp of Saskatchewan**[46] is a leading player in one of the fastest-growing segments in the fertiliser business – potash (which refers to potassium compounds and potassium-bearing materials).
The company is well positioned to meet increasing potash demand because of its low-cost operations and associated potash investments.

Figure 14.: Major potash producers
(Source: Fertecon, IFA, PotashCorp)

Million Tonnes KCl – 2009E



*PotashCorp Investments: ICL (14%), APC (28%), SQM (32%) and Sinofert (22%)
Note: Competitor capacity may exceed operational capability.

4.4 The sustainability dilemma

Intensive agricultural practices, if over- or misused, can have a negative health and environmental impacts

Increasing agriculture productivity through intensive farming methods such as irrigation, GM foods, fertilisers and pesticides is fundamental to rising global food production and to be able to meet actual food needs. It clearly reduces the amount of land needed for agriculture and permits more crops to remain intact. However, intensive agriculture can have a negative health and environmental impact, especially if over- or misused.

The improper use of fertilisers and other agrochemical inputs can have ***undesired ecological consequences***, such as the pollution of the environment with plant nutrients and agrochemical residues, the waste of limited freshwater resources and soil erosion, causing yields to fall in the long run and endangering food security. Poor irrigation practices are already responsible for the depletion of both surface-(rivers) and ground-water reserves. Concerns remain over the use of biotechnology and its implications for food safety as well as the wider long-term impact on the environment and on biodiversity. Additionally, this intensive form of agriculture – comprising around 13% of the total GHG emissions – ¬is contributing directly to climate change. This analysis excludes many of the upstream and downstream components of agriculture, such as the production of synthetic nitrogen fertilisers; when these are taken into account using lifecycle assessment factors, agriculture is seen to contribute between 25-30% of all GHG emissions.[47]

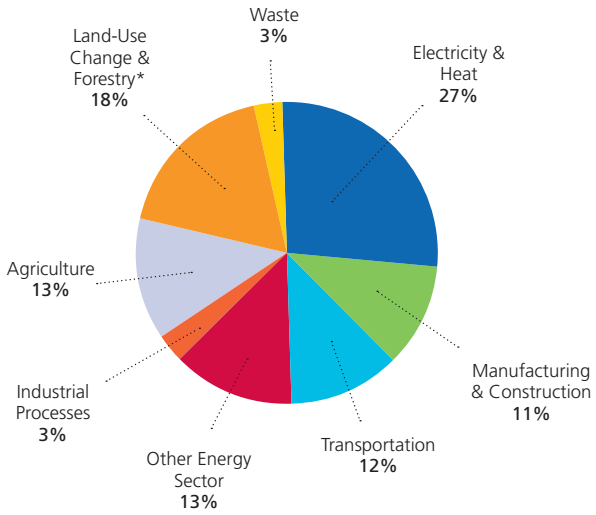
A study on the economics of ecosystems and biodiversity [48] reveals that a 'business-as-usual' scenario would have serious environmental consequences by 2050:

- 11% of the natural areas remaining in 2000 could be lost (predominantly as a result of pastures converted for agriculture, the expansion of infrastructure and climate change);
- 40% of the land currently under low-impact forms of agriculture would be impacted by environmental stress.

To address the sustainability dilemma, intensive farming needs to be used with more sustainable agricultural practices

While current available technologies, as described above, are often used in intensive agricultural practices to negative effect, they do have a significant role to play in more sustainable agricultural systems. A thorough understanding and implementation of the technology can result in production gains without detriment to the environment.

Figure 14.: Sources of Global Greenhouse Gas Emissions - Agriculture is the primary driver of land use change and deforestation
(Source: EarthTrends)



5. Implementing strategies to feed the world sustainably

"Future food production systems will not only depend on, but must contribute positively to, healthy ecosystems and resilient communities"
[UNEP, 2009]

- The concept of 'sustainable agriculture' can be viewed from a number of perspectives. However, there is consensus that it should represent an agricultural system which is productive and efficient while safeguarding the environment
- While there is no single solution to ensure food security in a sustainable manner, a combination of sustainable agricultural approaches (e.g., the more responsible use of agricultural technologies alongside ecologically sound farming methods) represents the most realistic response

Intensive farming and sustainable agricultural practices do not have to be mutually exclusive; understanding how and when to use agricultural technology is key

In view of the sustainability challenges – the need to increase food supply while attempting to achieve sustainable solutions – the concept of ***sustainable agriculture*** is gaining ground.[49] The Sustainable Agriculture Initiative (SAI) defines sustainable agriculture as "*a productive, competitive and efficient way to produce safe agricultural products, while at the same time protecting and improving the natural environment and social/economic conditions of local communities.*" Sustainable agriculture and biodiversity benefit most from the use of a rich variety of crops, both in terms of good crop protection practices and from the perspective of society at large and the values attached to food. As part of the concept, the FAO has declared a new strategic objective: The sustainable intensification of crop production or "Conservation Agriculture"[50], which is based on three synergistically interacting principles:

- minimum mechanical soil disturbance and tillage reduction methods;
- permanent soil cover with crops or mulch;
- diversified crop rotation with an appropriate percentage of legume crops.

Conservation agriculture, which is currently practised worldwide on about 100 million hectares (out of the 1.5 billion hectares of global farmland), has demonstrated that increased yields can be sustainably achieved with a lesser input of fertiliser and agrochemicals over time, while concurrently contributing to the emission of fewer GHGs. Combined with other complementary technologies (integrated pest management, the avoidance of soil compaction, agro-forestry, plant genetic progress, lower-meat diets,…), this would seem to be an effective tool for solving the problem of food scarcity in the long term.[51] Existing technologies such as irrigation, biotechnology and fertilisers can also play an important role, if used appropriately and sustainably.

Figure 15.: Conservation agriculture area: >30% ground cover (1000 ha)
(Source: Aquastat)

	1998-2002	2003-2007	2008-2012
Argentina	15001	19719	
Australia		9000	17000
Bolivia (Plurinational State of)	240	706	
Brazil	18744	25502	
Canada	8823	13481	
Chile		120	180
China		100	1330
Colombia		102	
Finland			200
France		150	200
Germany		354.1	
Ghana			30
Hungary		8	
Ireland		0.1	
Italy		80	
Kazakhstan		600	1300
Kenya		15	33.1
Lesotho		0.13	
Mexico		22.8	
Morocco			4
Mozambique		9	
Netherlands			
New Zealand			162
Paraguay	1200	2094	2400
Portugal		25	
Slovakia		10	
South Africa		300	368
Spain		300	650
Sudan			10
Switzerland		9	
Tunisia	0.027	6	
Ukraine			100
United Kingdom		24	
United States of America	22400	26500	
Uruguay	337.5	553.9	655.1
Venezuela (Bolivarian Republic of)		300	
Zambia	40		
Zimbabwe			15

Food Scarcity - Trends, Challenges, Solutions

The growing support for sustainably produced food will increasingly benefit producers, and is becoming standard practice among businesses that could use sustainable agricultural practices to ensure, among other things, the security of the food supply. For example, ***Unilever*** [52] has established a sustainable agriculture initiative to secure a sustainable supply of raw materials. The company has advocated that it has "*no choice but to pursue responsible agricultural practices…we can only reconnect with the consumer if Unilever is seen as a company that pursues sound environmental practices and is able to address in an open and honest way consumer concerns about the manner in which our raw materials are grown and delivered.*"[53] Within its sustainable agriculture initiative, Unilever has developed sustainable agricultural practices based on 11 indicators (including water, energy, pesticide use, biodiversity, social capital and animal welfare) and focusing on five key crops (spinach, peas, tomatoes, tea and palm oil). Taking as an example Unilever's palm oil, which currently accounts for about 4% of the world's supply, the company formalised its commitment to drawing all palm oil from certified sustainable sources by 2015. In November 2008, it bought the first certified sustainable palm oil and in early 2010 it stopped buying palm oil from two Indonesian planters – Duta Palma and Sinar Mas – over concerns of rainforest destruction.[54]

Figure 16.: Unilever's sustainable agriculture Key Performance Indicators
(Source: Unilever, 2008)

KPIs	Units	2008	2007
Tea used in Lipton Yellow Label and PG Tips in Western Europe from Rainforest Alliance Certified farms	% approximate	50	<1
Palm oil from sustainable sources	% approximate	<1	0
Suppliers self-assessing compliance with Sustainable Agriculture Guidelines	approximate proportion	1/3	N/A

There is substantial evidence to show that sustainable farming is expanding and improving current intensive farming practices. A commitment to sustainable agriculture is an innovative means of adapting to social and environmental concerns, while increasing agricultural productivity in the long term. Trends suggest that conventional agricultural technologies – such as providers of irrigation, genetic technology, fertilisers and pesticides – can also be part of the food scarcity solution. However, they need to adapt better to the apparent sustainability challenges and develop "low-input" technologies. Economically viable opportunities exist for those involved in the entire food value chain. Generating and sustaining consumer demand for sustainable products is also crucial, as the impact of food systems on human and ecological health is ultimately a consequence of consumption decisions. Businesses that meet these challenges are likely to benefit from the ongoing theme of food scarcity, gain a first-mover advantage over those involved in "business-as-usual" and be part of the solution to the food scarcity challenge.

Food Scarcity - Trends, Challenges, Solutions

[1] Intensive farming (intensive agriculture) is an agricultural production system characterised by high capital and labour input, or by the substantial use of technologies such as pesticides and chemical fertilisers relative to land area.

[2] **Hunger** is the most commonly used term to describe the social condition of people who frequently experience, or live with the threat of experiencing, the physical sensation of hunger. Source: http://www.fao.org/hunger/hunger-home/en/

[3] The **Global Hunger Index (GHI)**, adopted and further developed by the International Food Policy Research Institute, is a multidimensional statistical tool used to describe the state of hunger in different countries. The index ranks countries on a scale of 0 to 100, with 0 being the best score ("no hunger"), 100 the worst, though neither of these extremes is, in practice, achieved. The higher the score, the worse a country's food situation. A score of 4.9 or under reflects "low hunger", between 5 and 9.9 "moderate hunger", between 10 and 19.9 "serious hunger", between 20 and 29.9 "alarming hunger", and those exceeding 30 "extremely alarming hunger". The 2009 GHI was calculated for 121 developing countries and countries in transition, 84 of which were ranked.

[4] Credit Suisse, 2009, "Agriculture – a structural story".

[5] **Urbanisation**: the population of the world's 100 biggest cities grew from around 0.7m in 1900 to 6.2m in 2000. At present, half the world's population lives in urban areas. The UN estimates that, by 2030, 60% of the world's population will live in cities. **Land degradation**: approximately 40% of the world's agricultural land is seriously degraded. The main causes are soil erosion, loss of nutrients, damage from inappropriate farming practices and the misuse of agricultural chemicals.

[6] FAO-OECD

[7] Jean-Pierre Chauffour, 2008, "Global Food Price Cirsis – Trade Policy Origins", http://www1.worldbank.org/prem/PREMNotes/premnote119.pdf

[8] The Stern Report, 2006, www.hmtreasury. gov.uk/independent_reviews/stern_review_economics_climate_change/stern_review_report.cfm.

[9] IMF Commodity Price Index

[10] The severe weather conditions that affected Russia, the Ukraine, North America and Australia in 2006 and 2007 resulted in poor harvests. Wheat production in the US – the world's third-largest producer – fell by 16% in the 2007 campaign relative to 2006 because of heavy rain, while the prolonged drought in Australia – the world's second-largest wheat exporter – resulted in a halving of the 2007 harvest.

[11] OECD-FAO Agricultural Outlook, 2009, http://www.agri-outlook.org/dataoecd/5/27/43037451.pdf

[12] BBC World Service, 2009, "Food crisis hits developing world farms"; http://news.bbc.co.uk/2/hi/business/7905312.stm

[13] Malnutrition is the general term for a condition caused by improper diet or nutrition; Famine is the widespread scarcity of food that may apply to any faunal species, a phenomenon usually accompanied by regional malnutrition, starvation, epidemic, and increased mortality; Starvation describes a "state of exhaustion of the body caused by lack of food" and that could prove fatal.

[14] BBC, 2009, "World hunger hits one billion"; http://news.bbc.co.uk/2/hi/europe/8109698.stm

[15] The Economist, 2008; http://www.economist.com/world/international/displaystory.cfm?story_id=10566634

[16] World Bank, 2008

[17] IFPRI, 2004, Breaking the links between conflict and hunger in Africa, http://www.ifpri.org/sites/default/files/publications/ib26.pdf

[18] UNEP, 2007, "The Last Stand of the Orangutan - State of emergency: illegal logging, fire and palm oil in Indonesia's national parks"; http://www.unep.org/grasp/docs/2007Jan-LastStand-of-Orangutan-report.pdf

[19] United Nations, 2009

[20] Asia Times, 2006, http://www.atimes.com/atimes/South_Asia/HG21Df01.html

[21] Reuters News, 2009, "World Bank to Start Agriculture fund with $1.5 Bln"

[22] The Economist, 2009, "How to feed the world"

[23] CAP reform, 26/06/2003, http://ec.europa.eu/agriculture/capreform/index_en.htm

[24] Bound tariff: the maximum tariff rate allowed by the World Trade Organisation to any Member State for imports from another Member State.

[25] Julio Godoy, 2009, "FAO paper on land grab is wishy-washy"

[26] IFPRI, 2009, "Land Grabbing" by Foreign Investors in Developing Countries: Risks and Opportunities"

[27] The Economist, 2009, "Outsourcing's third wave"

[28] EurActiv, 2 April 2010, "EU wants to help small farmers in developing countries"

[29] Compassion in World Farming and Friends of the Earth, 2009, "Eating the planet?", http://www.foe.co.uk/resource/briefings/eating_planet_briefing.pdf

[30] On average, the proportion of animal protein in the diet should decrease to 30%, from a global average of 38% in 2000.

[31] Stehfest et al., 2009

[32] Based on Dexia AM's sustainability analysis of emerging markets companies, Jain Irrigation has been included in the SRI universe

[33] "An organism is "genetically modified" if its genetic material has been changed in a way that does not occur under natural conditions through cross-breeding or natural recombination – Article 2 of the EU Directive on the Deliberate Release into the Environment of Genetically Modified Organisms (2001/18/EG)."

[34] The International Service for the Acquisition of Agri-biotech Applications (ISAAA), 2007, "Global Status of Commercialized Biotech/GM Crops: 2007", http://www.isaaa.org/Resources/Publications/briefs/37/executivesummary/pdf/Brief%2037%20-%20Executive%20Summary%20-%20English.pdf

[35] Agbios, biotech crop database

[36] Based on Dexia AM's sustainability analysis of the Chemicals Sector, Syngenta has been excluded from the SRI universe.
[37] Based on Dexia AM's sustainability analysis of the Chemicals Sector, DuPont has been included from the SRI universe.
[38] Based on Dexia AM's sustainability analysis of the Chemicals Sector, Monsanto has been excluded from the SRI universe.
[39] Barroso veut imposer la culture des OGM dans l'UE, http://www.lesechos.fr/depeches/science-environnement/afp_00228669-barroso-veut-imposer-la-culture-des-ogm-dans-l-ue.htm; 08/02/10
[40] International Assessment of Agricultural Knowledge, Science and Technology for Development http://www.agassessment.org/index.cfm?Page=IAASTD%20Reports&ItemID=2713
[41] Compassion in World Farming and Friends of the Earth, 2009, "Eating the planet?", http://www.foe.co.uk/resource/briefings/eating_planet_briefing.pdf
[42] These are chemicals that are applied to soil to provide crops with nutrients. Nitrogen in the available form of nitrates is an example of a nutrient essential for plants that can be provided by fertilisers.
[43] These are chemicals that are put on crops (usually sprayed) and which include herbicides, insecticides and fungicides. Pesticides are designed to kill off certain pests.
[44] http://www.who.int/heli/risks/toxics/chemicals/en/index.html
[45] Citigroup, 2010, "Chemicals Presentation"
[46] Based on Dexia AM's sustainability analysis of the Chemicals Sector, Potash Corp has been included in the SRI universe.
[47] Niggli, U., Schmid, H., and Fliessbach, A., Organic Farming and Climate Change. 2007, Geneva, Switzerland: International Trade Centre UNCTAD/WTO, Research Institute of Organic Agriculture (FiBL). 38. http://orgprints.org/13414/
[48] Sukhdev, 2008, http://ec.europa.eu/environment/nature/biodiversity/economics/pdf/teeb_report.pdf
[49] IAASTD, 2009. Agriculture at a Crossroads. International Assessment of Agricultural Knowledge, Science and Technology for Development (IAASTD), Global Report. Island Press, Washington, D.C.
[50] FAO, Conservation Agriculture, http://www.fao.org/ag/ca/index.html
[51] FAO, 2009, "Hunger in the world – Is the current way of doing farming still up to date?", http://www.fao.org/agriculture/crops/news-events-bulletins/detail/en/item/20336/icode/?no_cache=1
[52] Based on Dexia AM's sustainability analysis of the Food, Beverage and Tobacco Sector, Unilever has been included in the SRI universe
[53] Unilever magazine, Cultivating Sustainable Agriculture, http://www.unilever.com/images/2001%20Cultivating%20Sustainable%20Agriculture_tcm13-5312.pdf
[54] Roundtable on Sustainable Production; http://www.rspo.org/What_is_RSPO@.aspx

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