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# Feeding a world of 9 billion

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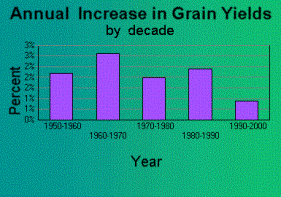
Far from decreasing, the number of hungry people in the world is currently increasing

FAO Director-General Jacques Diouf

**Malthusian fears that population growth will outstrip food supplies have been widely discounted as food production has kept well ahead of growing human numbers in the last half century. (While population doubled, food supply tripled, and life expectancy increased from 46 in the 1950s to around 65 today.) But more recently, some experts have once again been sounding the alarm about a possible food crisis.**

The reason lies in the combined impact of many factors including climate change, forest denudation, land degradation, water shortage, declining oil supplies, species extinction, destruction of coastal ecosystems and the growing demands for a meat-rich diet from newly developed parts of the world.

At the root of all these problems has been the ruthless exploitation of the earth'™s resources, fuelled by growing affluence in some parts of the world and desperate poverty in others - allied to burgeoning human numbers. Between 1980 and 2000, global population rose from 4.4 billion to 6.1 billion, while food production increased 50 per cent. By 2050, the population is expected to reach 9 billion.



The graph shows that while grain yields per acre have been increasing, the rate of increase has been slowing since the days of the Green Revolution in the 1970s. Most of the benefits of irrigation, machinery, fertilizer and plant breeding have already been realized. The production of grain per acre is close to the maximum obtainable through photosynthesis. Source: Worldwatch/FAO

To keep up with the growth in human population, more food will have to be produced over the next 50 years than has been during the past 10,000 years combined, said the participants of the recent UN-backed forum in Iceland on sustainable development. It is, of course, possible that new technologies, smart environmental management and sensitive social policies will combine to good effect to usher in a new 'double green' revolution. But as grain reserves have fallen to their lowest level for many years, this cannot be guaranteed

### Child survival

Nor is it only a question of food supply. The reason why 850 million people go hungry each day - the vast majority being rural dwellers in the developing world - probably has less to do with food production than poverty - the rich never starve, the poor often do. But there is a fear now that food shortages may themselves lead to instability, famine and mass migration. Per capita food production and consumption has been falling for some years in sub-Saharan Africa, along with life expectancy. And it is in poor African countries such as Malawi, Niger and Ethiopia that population is growing fastest, where the fertility of the land is falling most rapidly, and where the ability to absorb newcomers in the cities is most weak.

At the 1996 World Food Summit political leaders from 186 countries pledged to halve the number of hungry people in the world by the year 2015 - or a reduction of 20 million each year. At that time, about 800 million people were reported to suffer from under-nourishment. In 2007 estimates from the UN Food and Agriculture Organization (FAO) suggest that there are 854 million people who do not get enough to eat everyday. "Far from decreasing, the number of hungry people in the world is currently increasing," said FAO Director-General Jacques Diouf. (Of course, world population has increased by some 800 million in that time, so food supplies have kept up relatively well, but have failed to reach an increasing number, let alone reduce the total going hungry).

For young children, the lack of food can be perilous since it retards their physical and mental development and threatens their very survival. In fact, some 5.6 million children die from hunger-related illness every year before their fifth birthday.

### Environmental hazards

The global increase in food production can be largely attributed to the Green Revolution. The introduction of high-yielding seed varieties, the widespread use of artificial fertilisers and pesticides and an increase in irrigated cropland boosted yields of rice, wheat and other staples. Throughout the 1970s and 1980s yields per hectare increased by around 2 per cent a year, although over the past 15 years that has slowed.

According to the International Food Policy Research Institute, the annual growth in cereal yields is projected to fall to about one per cent during the next two decades. However, the Food and Agricultural Organisation estimates that total food production of all sorts will grow annually at about 1.5 per cent over the next 30 years, keeping ahead of population growth, now running at 1.3 per cent a year.

However, there has been a price to pay in terms of the environmental side effects. The Green Revolution has been massively dependent upon inputs of fossil fuels, now seen as both damaging to the climate and increasingly expensive as oil supplies peak. Agricultural intensification has had a profound impact on biodiversity, and the use of pesticides in particular has led - in the words of Lord May, former President of the Royal Society, "to an ever more Silent Spring." May anticipates a 10-fold increase in extinction rates over the coming few centuries, and much of this will be attributable to the way we produce food.

### Water crisis

Irrigation has been a key factor in enabling us to increase food production. Today, about 40 per cent of the world's food comes from the 18 per cent of cropland that gets irrigation water. Since Asia's agricultural revolution, the amount of land under irrigation has tripled. However, the demand for irrigation water is leading to its over-exploitation in many parts of the world.



Irrigating rice with a shadoof, Bangladesh. Photo © SBG McCullagh/Holt Studios

Rivers like the Colorado in the United States no longer reach the sea: every drop is taken, mostly to irrigate the crops in California. "The Ganges and the Yellow River no longer flow," said Professor Jeffrey Sachs, Director of the UN's Millennium Project. "There is so much silting up and water extraction upstream they are pretty stagnant."

In the Middle East, India and China farmers are taking ground water faster than nature can replenish it, and disputes over water are becoming increasingly common. Agriculture accounts for 70 per cent of all water used globally, and as much as 90 per cent in many developing countries. To keep pace with the growing demand for food, it is estimated that 14 per cent more freshwater will need to be withdrawn for agricultural purposes in the next 30 years. Take the case of rice, the staple cereal of nearly half the world's total population. Current rice production systems consume a high amount of water. It takes about 3,000 litres of water to produce one kilogram of rice. Irrigated non-agriculture areas, which provide 75 per cent of total Asian rice production, consume 50 per cent of all freshwater diversions.

"This profligate usage of water in irrigated rice production is unsustainable, given the increasing demand for freshwater due to growth in rice demand and growing competition from other sectors," said Tumurdavaa Bayarsaihan, a senior agricultural economist at the Manila-based Asian Development Bank.

Much of the water taken for irrigation - probably over a half - never reaches the crops for which it is intended: it evaporates, leaks out of broken pipes or is otherwise wasted. Of equal concern is the mismanagement of irrigation water. According to the United Nations' Food and Agricultural Organisation (FAO) 30 million hectares out of the world's 240 million irrigated hectares have been severely damaged by a build up in salt, and a further 80 million hectares are affected by a combination of salinisation and water logging.

**Forest clearance** Trees have become another victim of forest clearance for cash cropping, biofuels, oil and human settlement. Seen by Frank Lloyd Wright as the 'best friend on earth of man' when used 'respectfully and economically' forests and trees offer a direct contribution to food supply and to nutritional well-being: provide a source of income necessary to purchase food; give protection to the resource base upon which food production depends; and provide a source of fuel wood. Tropical rainforest is host to some 2,500 species of fruits fit for human consumption. Only a few - banana, grapefruit, and pineapple - have been commercialised.

These and other forests are fast disappearing at alarming rate. The FAO's State of the World's Forests 2007 reported that from 1990 to 2005, the world lost 3 per cent of its total forest area, an average decrease of some 0.2 per cent per year. Net forest loss is 7.3 million hectares per year or 20,000 hectares per day, equivalent to an area twice the size of Paris.

**Land degradation**The denudation of the ecologically fragile forests is causing erosion of the most valuable source of farming - topsoil. The world loses the equivalent of five to seven million hectares of farmland through erosion each year. This is equivalent to the land area of Belgium and the Netherlands combined. A recent study by the Royal Commission on Environmental Pollution concluded that approximately 30 per cent of the world's arable crop land has been abandoned because of severe soil erosion in the last 40 years.



Eroded land in Ethiopia - 40 per cent of global productive land is affected. Photo © Sean Sprague / Panos Pictures

It takes 200 to 1,000 years to form 2.5 centimetres of rich topsoil. But on the average, farmlands are losing 2.5 centimetres of topsoil every 16 years, or 17 times faster than it can be replaced. "Soil erosion is any nation's enemy - far worse than any outside enemy coming into a country and conquering it because it is an enemy you cannot see vividly," said Harold R. Watson, Ramon Magsaysay award-winning soil scientist. "It's a slow creeping enemy that soon possesses the land."

Some 40 per cent of the world's agricultural land is seriously degraded. Among the worst affected regions are Central America, where 75 per cent of land is infertile, Africa, where a fifth of soil is degraded, and Asia, where 11 per cent is unsuitable for farming. **Vanishing livestock**Nearly two billion people globally rely on livestock to meet part or all of their daily needs. "Livestock now meet 30 per cent of total human needs for food and agricultural production, converting low-quality biomass, such as corn stalks and other crop residues, into high-quality milk and meat," wrote Danielle Nierenberg in another Worldwatch report.



Small-scale pig rearing, Philippines. Photo © Henrylito Tacio

In the coming years, meat consumption is expected to rise. The Washington-based International Food Policy Research Institute estimates that by 2020, people in developing countries will consumer more than 36 kilograms of meat per person, twice as much as in the 1980s.

Unfortunately, important breeds of livestock are also fast disappearing. The Criolla Mora sheep, which can be traced back in 1548, are used for meat and wool and they are resistant to parasite infestation. Scientists are now uncertain how many remain - anywhere from 100 to 1,000 live in the Colombian highlands.

According to FAO's State of the World's Animal Genetic Resources report, at least one livestock breed a month has become extinct over the past seven years. Around 20 per cent of the world's breeds of cattle, goats, pigs, horses and poultry are currently at risk of extinction. "Wise management of the world's animal genetic resources is of ever greater importance," said FAO Assistant Director-General Alexander Muller.

Jose Esquinas-Alcazar, Secretary of the Commission on Genetic Resources for Food and Agriculture, considers genetic resources as "the basis of food security." He compares the thousands of different breeds of crops and livestock to Lego blocks: "Just as children a variety of different size and colour blocks to build a building or castle, we also need all the little pieces of genetic diversity in agriculture to build food security."

### 'Last wild meal'

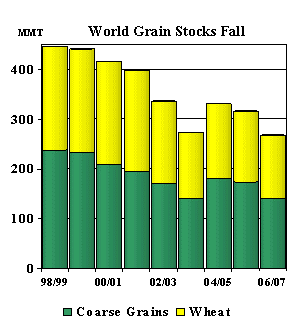
Fish are the "last wild meal" in the human diet. For nearly one billion, mostly in Asia, fish supply 30 per cent of protein; worldwide, the figure is just six per cent. However, the world's fish and seafood populations are in deep trouble. Declining fish stocks are not the only problem. As more and more dams are allowed on the lower reaches of the Mekong, for example, the main protein supply, from fish, of some 60 million people in the Mekong basin in SE Asia could be threatened.

In an analysis of scientific data going back to the 1960s and historical records over a thousand years, the researchers found that marine biodiversity - the variety of ocean fish, shellfish, birds, plants and micro-organisms - has declined dramatically, with 29 per cent of species already in collapse.

"Species have been disappearing" faster and faster, deplored lead author Boris Worm of Dalhousie University in Halifax, Canada. "If the long-term trend continues, all fish and seafood species are projected to collapse within my lifetime." "Collapse" is de fined as the catch of a species dropping by 90 per cent. (See more in Coasts and Oceans Overview and Factfile)

### Threat of biofuels

The threat of a food crisis is exacerbated by fears over energy security, with many countries now opting to plant biofuels crops in place of traditional crops. India, for instance, has pledged to meet 10 per cent of its vehicle fuel needs with biofuels.



Grain wheat production has fallen in the Black Sea region and the United States. Strong demand for bio-ethanol has reduced corn stocks. Source: US Dept of Agriculture.

As a result of this new trend, food prices have been escalating. In the United States, for example, corn prices have doubled over the last year. In Mexico, where most people eat corn, the price of tortillas is up by 60 per cent. The soaring use of corn as the feedstock for fuel ethanol, according to a Bloomberg analysis, "is creating unintended consequences throughout the global food chain."

Corn is just one of the six top cereal crops in the world, along with rice, wheat, oats, sorghum, and barley. All are good sources of ethanol, a clean-burning, high-octane alcohol. "If the fuel value of grain exceeds its food value, the market will move it into the energy economy," observes Lester R. Brown, president of the Washington-based Earth Policy Institute. "As the price of the oil climbs so will the price of food."

### Keeping pace with demand?

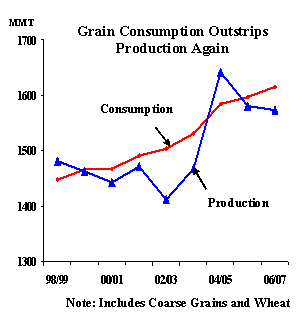
Most experts agree that if we are to feed 8 billion people - many of them demanding a meat-rich diet - in 2030, then world food production will have to increase by at least 40 per cent. In the view of FAO, 80 per cent of this increase will have to come from more intensive crop production, and the remaining 20 per cent from expansion of arable land, much at the expense of existing forests.

"Sustainable intensification without further degradation of natural resources and environment still remains a challenge," it suggested in its 2000 report Agriculture: Towards 2015/2030. While FAO admits that the number of hungry will remain "stubbornly high", it believes that growth in food production, although slower than in the past, will still outstrip population growth.

[Link to Summary of Agriculture: Towards 2015/2030](http://www.fao.org/NEWS/2000/000704-e.htm).

Over the past two decades food prices have steadily declined, and the IFPRI anticipated that food prices would either continue to decline, or remain steady, over the next 20 years. This is a view that has been hotly contested by the Worldwatch Institute, which for some years has been arguing that food prices will rise in response to falling per capita production and a rapid growth in demand in the developing world, as now appears to be happening. And certainly, almost all the increase in food demand will come from the developing world, partly because that is where the growth in population will occur, and partly because a rise in affluence will lead to greater demands for meat, which in turn will fuel the demand for feed grain.

Worldwatch believes that water shortages, and the further degradation of agricultural land through soil erosion, salinisation and waterlogging, pose a serious threat to food production in the future. It also points to the huge increases in grain imports that can be expected to be made in China, with its growing population and its appetite for meat at a time when that country is losing agricultural land to other uses and to erosion.



Rising consumption is expected to outstrip production for the second straight year. Source: US Dept of Agriculture

Lester Brown of the Earth Policy Institute also draws attention to the fall in grain production in China in recent years (down by 34 million tons, or 9 per cent, between 1998 and 2005) and warns that falling water tables will add to the difficulty of stepping up production. The resulting rise in imports, and in grain prices, has already had global repercussions, he says. However, the latest forecasts for China's harvest in 2006-7 from the US Department of Agricultrure, projected a big bounce back in grain production owing to increased acreage sown and 'exceptional conditions', with a corrsponding reduction in imports.

At the same time, the International Food Policy Research Institute (IFPRI) suggests that many of the high global estimates for land degradation are unsubstantiated. IFPRI believes that land degradation constitutes "a modest threat only" and forecasts supply substitution: countries with food shortages will simply import more from temperate regions where environmental problems are less of an issue.

### Changing climate

That may not fully take into account the impact on food supplies of climate change. Experts have agreed that abnormal changes in air temperature and rainfall and the increasing frequency and intensity of drought and floods have long-term implications for the viability and productivity of world agro-ecosystems.

"Agriculture is the sector most affected by changes in climate patterns and will be increasingly vulnerable in the future," said FAO in a press statement. "Especially at risk are developing countries, which are highly dependent on agriculture and have fewer resources and options to combat damage from climate change."

Farming is most dependent on stable climate. "The most serious threats will not be occasional severe drought or heat wave but subtle temperature shifts during key periods in the crop's life cycle, as these are most disruptive to plants bred for optimal climatic conditions," wrote Danielle Nierenberg and Brian Halweil in a Worldwatch report.

In Asia, plant scientists have found that rising temperatures may reduce grain yields in the tropics by as much as 30 per cent over the next 50 years.

### Sustainable agriculture

There is also much talk today of sustainable agriculture. This describes systems of food production where farmers work with nature, rather than chafe against it. Instead of blitzing micro-organisms with pesticides, they use integrated pest management (IPM), and encourage beneficial insects at the expense of pest species. Rather than relying on artificial fertilisers to maintain fertility, farmers rotate their crops; use animal manures and plant crops, which can be used as green manure.



Organic farmer in India ploughing green manure into his fields. Photo © Organic India

"If we can improve agricultural practices across the board, we can dramatically increase our food production from existing lands, without to clear more or put more pressure on soils. Simple things like good crop rotation, sowing at the right time of the year, basic weed control, are what are needed. They're very well known but not always used," said Andrew Campbell, an Australian environmental consultant.

Sustainable agriculture emphasises the importance of management over technology, and relies heavily on farmers' participation in the decision-making process, and equitable access to local resources. Among the most comprehensive analyses of sustainable agriculture have been those done by the International Institute for Environment and Development (IIED). These suggest that in many countries where it is practised crop yields have increased dramatically, as have local incomes. This is highly significant, as malnutrition is often the scourge of remote rural areas.

There is little doubt that sustainable agriculture - as defined here and practised as far afield as Honduras, the Philippines and Mali - can bring considerable benefits to many parts of the world, but sustainable agriculture alone will not be enough to ensure the food security of the growing numbers of rural poor. As IIED's John Thompson suggests, pricing policy, credit systems, gender discrimination and policies that neglect the poor all need to be tackled if the poor are to get a better deal.

More contentious - for many environmentalists, at least - is the call for a "doubly green" revolution, a phrase coined by Gordon Conway of the Rockefeller Foundation. His believes that if we are to feed the world in the 21st century and avoid future economic and civil dislocation, we need a new kind of agriculture - one which is doubly green, where the conservation of resources and the production of large quantities of food are not inimical. Conway believes we need to design new and better plants and animals, and use biotechnology to do so; we need to develop non-polluting alternatives to inorganic fertilisers, to improve soil quality, to enhance opportunities for the rural poor, especially for women, and to forge equitable partnerships between researchers and farmers.

### Biotechnology boon?

The issue of genetically modified organisms - GMOs - has proved highly contentious, especially in the developed world (where, as a rule, there are no food shortages and little malnutrition, other than the variety which stems from overeating).

Advocates of biotechnology point to its many possible benefits. In the future scientists may develop GMOs which lead to a dramatic reduction in the use of pesticides and artificial fertilisers. Recently scientists developed a genetically modified strain of rice, golden rice, which contains vitamin A and extra iron, and a strain of vitamin A-rich sweet potato acceptable in sub-Saharan Africa. Every year over a million children die of vitamin A-related diseases: golden rice could prevent such deaths. Conway believes that the tools of biotechnology are essential if crop yields are to be raised.

Opponents of GMOs, on the other hand, believe that the risks are too great. They fear that gene transfer to wild relatives of genetically modified crops may give rise to super weeds, and they are also concerned about the impact of GMOs on human health. They see the introduction of GMOs, which are largely developed and sold by a handful of multinational corporations, as further evidence of the industrialisation of agriculture, and a further nail in the coffin of small farmers. Dr. Peter Wills, a theoretical biologist at Auckland University, points out, "By transferring genes across species barriers which have existed for eons, we risk breaching natural thresholds against unexpected biological processes."

Ultimately, it is the nature of society, as much as science, which will determine whether the world can adequately feed all its inhabitants in the future. The poor need not only better access to food, but also the means to buy it. Above all, this means raising rural incomes, and this requires fairer trading relationships. At present the economic policies of the rich world, particularly when it comes to subsidising and protecting its own agricultural industry, discriminate against farmers in many other parts of the world. At the same time many developing world governments keep food prices artificially low and fail to invest in the rural economy. By doing so, they discriminate against small farmers. Political reforms will count for just as much as agricultural innovation in the war on hunger.

Updated and revised by Henrylito Tacio, East Asia Contributing Editor..