How to Feed the World in 2050

Executive Summary

By 2050 the world's population will reach 9.1 billion, 34 percent higher than today. Nearly all of this population increase will occur in developing countries. Urbanization will continue at an accelerated pace, and about 70 percent of the world's population will be urban (compared to 49 percent today). Income levels will be many multiples of what they are now. In order to feed this larger, more urban and richer population, food production (net of food used for biofuels) must increase by 70 percent. Annual cereal production will need to rise to about 3 billion tonnes from 2.1 billion today and annual meat production will need to rise by over 200 million tonnes to reach 470 million tonnes.

This report argues that the required increase in food production can be achieved if the necessary investment is undertaken and policies conducive to agricultural production are put in place. But increasing production is not sufficient to achieve food security. It must be complemented by policies to enhance access by fighting poverty, especially in rural areas, as well as effective safety net programmes.

Total average annual net investment in developing country agriculture required to deliver the necessary production increases would amount to USD 83 billion. The global gap in what is required vis-à-vis current investment levels can be illustrated by comparing the required annual gross investment of US$209 billion (which includes the cost of renewing depreciating investments) with the result of a separate study that estimated that developing countries on average invested USD 142 billion (USD of 2009) annually in agriculture over the past decade. The required increase is thus about 50 percent. These figures are totals for public and private investment, i.e. investments by farmers. Achieving them will require a major reallocation in developing country budgets as well as in donor programmes. It will also require policies that support farmers in developing countries and encourage them and other private participants in agriculture to increase their investment.

In developing countries, 80 percent of the necessary production increases would come from increases in yields and cropping intensity and only 20 percent from expansion of arable land. But the fact is that globally the rate of growth in yields of the major cereal crops has been steadily declining, it dropped from 3.2 percent per year in 1960 to 1.5 percent in 2000. The challenge for technology is to reverse this decline, since a continuous linear increase in yields at a global level following the pattern established over the past five decades will not be sufficient to meet food needs. Although investment in agricultural R&D continues to be one of the most productive investments, with rates of return between 30 and 75 percent, it has been neglected in most low income countries. Currently, agricultural R&D in developing countries is dominated by the public sector, so that initially additional investment will have to come from government budgets. Increasing private sector investment will require addressing issues of intellectual property rights while ensuring that a balance is struck so that access of smallholder farmers to new technologies is not reduced.

Hunger can persist in the midst of adequate aggregate supplies because of lacking income opportunities for the poor and the absence of effective social safety nets. Experience of countries that have succeeded in reducing hunger and malnutrition shows that economic growth does not automatically ensure success, the source of growth matters too. Growth originating in agriculture, in particular the smallholder sector, is at least twice as effective in

benefiting the poorest as growth from non-agriculture sectors. This is not surprising since 75 percent of the poor in developing countries live in rural areas and their incomes are directly or indirectly linked to agriculture. The fight against hunger also requires targeted and deliberate action in the form of comprehensive social services, including food assistance, health and sanitation, as well as education and training; with a special focus on the most vulnerable.

Many countries will continue depending on international trade to ensure their food security. It is estimated that by 2050 developing countries' net imports of cereals will more than double from 135 million metric tonnes in 2008/09 to 300 million in 2050. That is why there is a need to move towards a global trading system that is fair and competitive; and that contributes to a dependable market for food. Reform of farm support policies in OECD countries is a welcome step which has led to a decline in the aggregate trade distortion coefficient from 0.96 in 1986 to 0.74 in 2007. However, there is clearly still room for improvement. There is also a need to provide support and greater market access to developing country farmers so that they can compete on a more equal footing. Countries also need to consider joint measures to be better prepared for future shocks to the global system, through coordinated action in case of food crises, reform of trade rules, and joint finance to assist people affected by a new price spike or localized disasters.

Climate change and increased biofuel production represent major risks for long-term food security. Although countries in the Southern hemisphere are not the main originators of climate change, they may suffer the greatest share of damage in the form of declining yields and greater frequency of extreme weather events. Studies estimate that the aggregate negative impact of climate change on African agricultural output up to 2080-2100 could be between 15 and 30 percent. Agriculture will have to adapt to climate change, but it can also help mitigate the effects of climate change, and useful synergies exist between adaptation and mitigation. Biofuel production based on agricultural commodities increased more than threefold from 2000 to 2008,. In 2007-08 total usage of coarse grains for the production of ethanol reached 110 million tonnes, about 10 percent of global production. Increased use of food crops for biofuel production could have serious implications for food security. A recent study estimates that continued rapid expansion of biofuel production up to 2050 would lead to the number of undernourished pre-school children in Africa and South Asia being 3 and 1.7 million higher than would have been otherwise the case. Therefore, policies promoting the use of food-based biofuels need to be reconsidered with the aim of reducing the competition between food and fuel for scarce resources.

The world has the resources and technology to eradicate hunger and ensure long-term food security for all, in spite of many challenges and risks. It needs to mobilize political will and build the necessary institutions to ensure that key decisions on investment and policies to eradicate hunger are taken and implemented effectively. The time to act is now.

How to Feed the World in 2050

1. Introduction

The sharp increases in food prices that occurred in global and national markets in recent years, and the resulting increases in the number of hungry and malnourished people, have sharpened the awareness of policy-makers and of the general public to the fragility of the global food system. This awareness must be translated into political will and effective action to render the system better prepared to respond to long-term demand growth and more resilient against various risk factors that confront world agriculture, and to ensure that the growing world population will be able to produce and have access to adequate food today and in future. There is a need to address new challenges that transcend the traditional decision-making horizons of producers, consumers and policy-makers.

In the first half of this century, global demand for food, feed and fibre is expected to grow by 70 percent while, increasingly, crops may also be used for bio-energy and other industrial purposes. New and traditional demand for agricultural produce will thus put growing pressure on already scarce agricultural resources. And while agriculture will be forced to compete for land and water with sprawling urban settlements, it will also be required to serve on other major fronts: adapting to and contributing to the mitigation of climate change, helping preserve natural habitats and maintaining biodiversity. To respond to those demands, farmers will need new technologies to produce more from less land, with fewer hands.

This perspective for 2050 raises a number of important questions. Are current public and private investments sufficient to ensure adequate agricultural production potential, sustainable use of natural resources, infrastructure for markets, information and communication and research for technological breakthroughs for the future? Will resources, new technologies and supporting services be available to the people who will need them most - the poor? What needs to be undertaken to help agriculture meet the challenges of climate change and growing energy scarcity? What can be done to ensure food security in sub-Saharan Africa, the continent facing the highest population growth rates, the severest impacts from climate change and the heaviest burden of HIV/AIDS?

To consider these and associated questions, FAO convened a three-day Meeting of Experts in Rome in June 2009. The following document takes major findings of that meeting into account and aims to serve as a basic background for the High-Level Experts Forum on "How to Feed the World in 2050", to be convened at FAO Headquarters in Rome on 12-13 October 2009.

At the Expert Meeting in June there was consensus among participants that it should be possible to produce enough food in 2050 to meet the needs of a world population that will have increased to more than 9 billion, but that this positive outlook assumed certain conditions are met and policy decisions taken. Two conditions were considered essential for success in meeting the expected food needs on a sustainable basis. One is increased investment in research and development for sustained productivity growth, infrastructure institutional reforms, environmental services and sustainable resource management. The other is that policies should not simply focus on supply growth, but also on access of the world's poor and hungry to the food they need to live active and healthy lives.

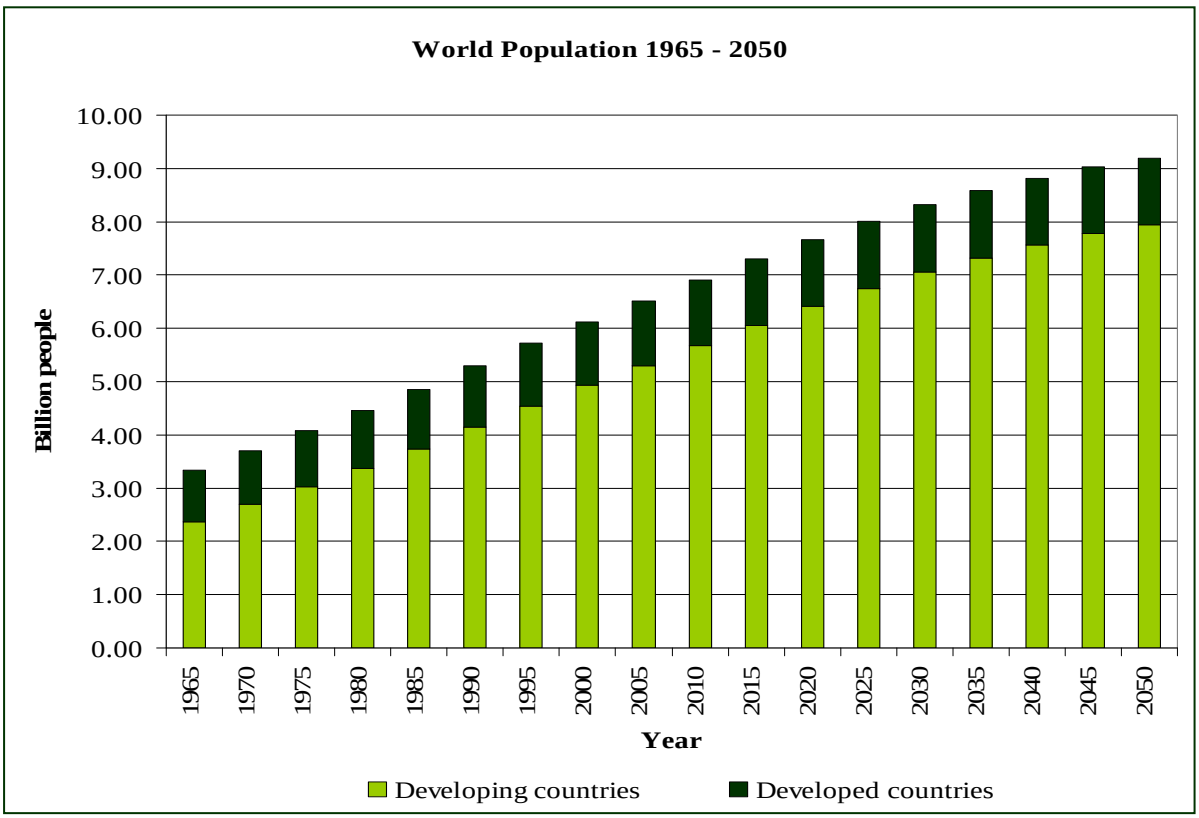
2. Outlook for Food Security towards 2050

In the following, the key elements of current expert thinking regarding the outlook for food security towards 2050 will be summarized. The key message from this assessment is that it will be possible to achieve food security for a world population of 9.1 billion people projected for that time, provided a number of well specified conditions are met through appropriate policies.

2.1 The changing socio-economic environment

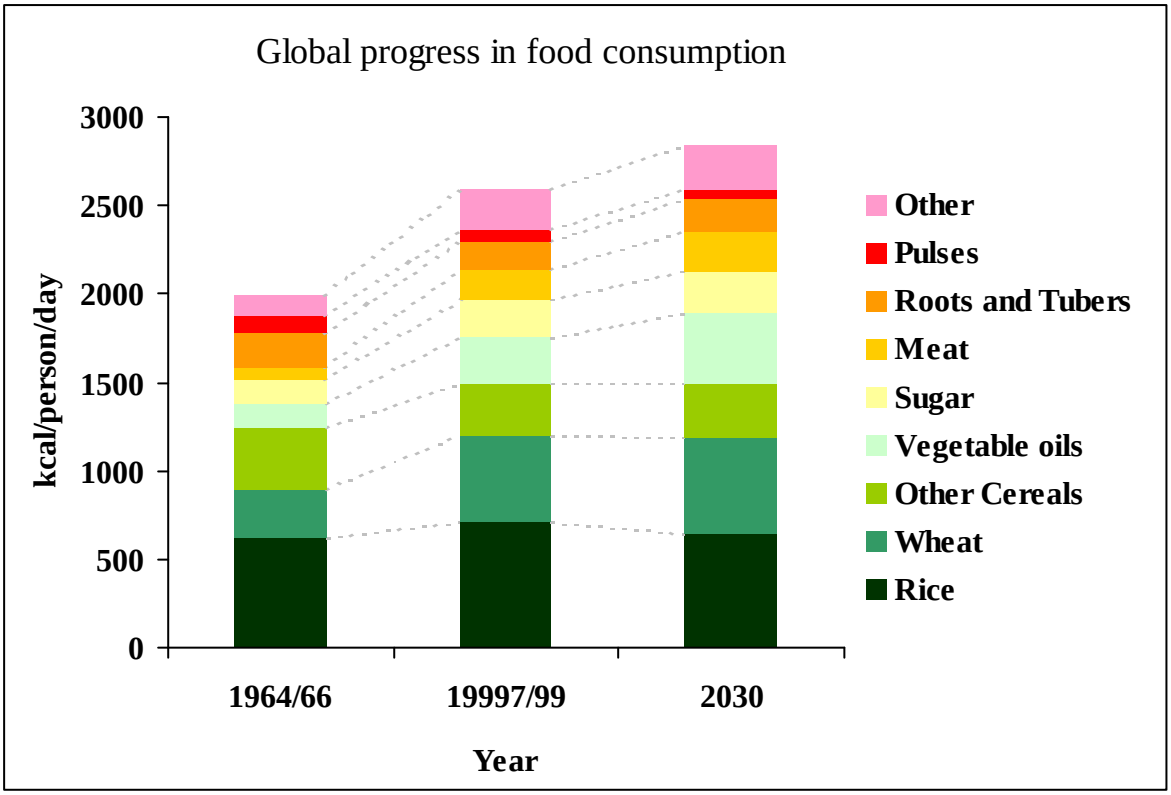
The main socio-economic factors that drive increasing food demand are population growth, increasing urbanization and rising incomes. As regards the first two, population growth and urbanization, there is little uncertainty about the magnitude, nature and regional pattern of their future development.

According to the latest revision of the UN **population prospects** (medium variant), the world population is projected to grow by 34 percent from 6.8 billion today to 9.1 billion in 2050. Compared to the preceding 50 years, population growth rates will slow down considerably. However, coming off a much bigger base, the absolute increase will still be significant, 2.3 billion more humans. Nearly all of this increase in population will take place in the part of the world comprising today's developing countries. The greatest relative increase, 120 percent, is expected in today's least developed countries.



Source: Population Division of the Department of Economic and Social Affairs of the United Nations Secretariat (2007)

All of the growth in the world's population, and some more, will take place in **urban** areas. By 2050 more than 70 percent of the world's population is expected to be urban. Urbanization will bring with it changes in life styles and consumption patterns. In combination with income growth it may accelerate the ongoing diversification of diets in developing countries. While the shares of grains and other staple crops will be declining, those of vegetables, fruits, meat, dairy, and fish will increase. In response to a rising demand for semi-processed or ready-to-eat foods, the whole structure of market chains is likely to continue its dynamic change towards a further concentration of supermarket chains. While the share of the urban population is growing, however, rural areas will still be home to the majority of the poor and hungry for quite some time. Currently, one billion people cannot even satisfy their basic needs in terms of food energy. Living in hunger hot spots, often ecologically fragile areas, many of them have to cope with conditions of high population pressure and deteriorating ecosystems.

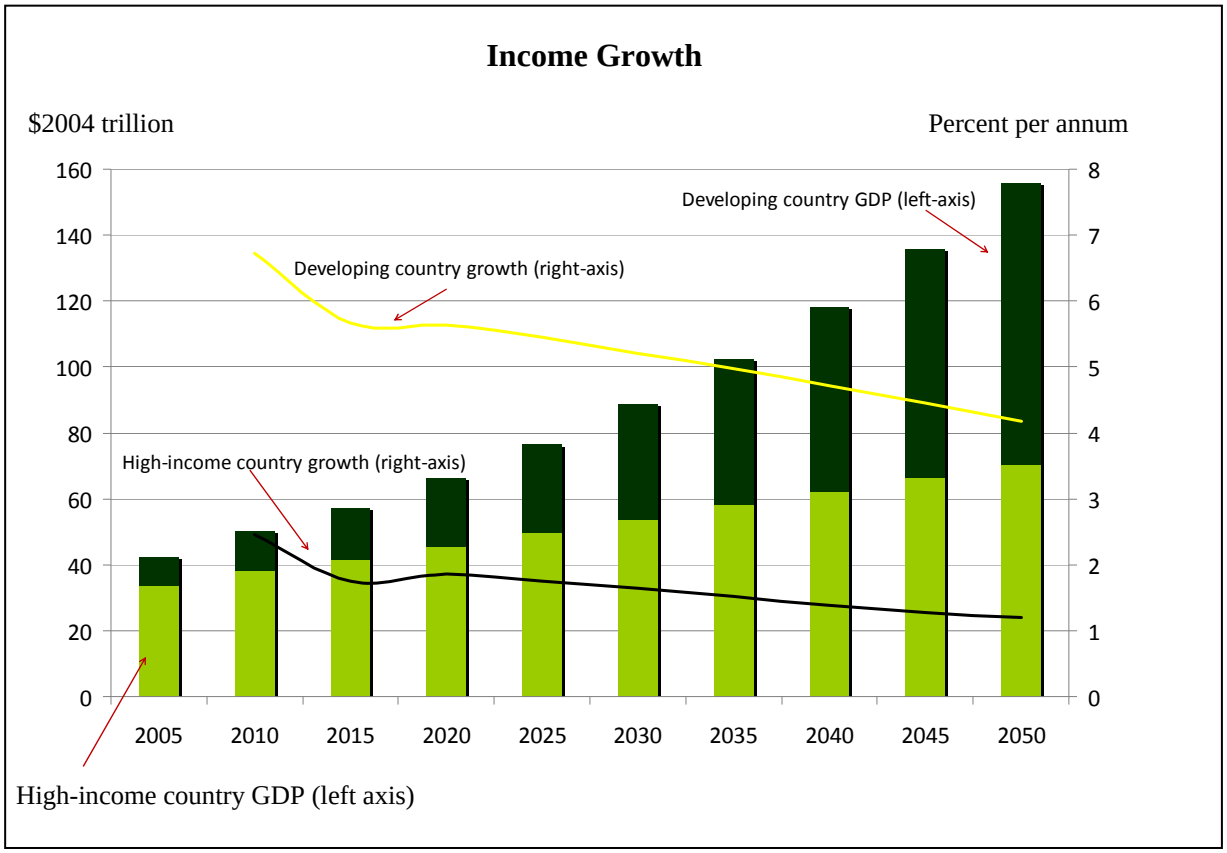


Source: FAO (2002)

Despite urbanization, rural populations will grow faster than employment in primary agriculture, which is typically the case in transforming countries, so governments must facilitate the gradual **transition to non-agricultural employment.** This will require an institutional environment in rural areas that is conducive to multiple sources of employment and income generation. In Asia and Latin America a large proportion of the rural labour force is already working full or part-time in non-agricultural jobs. In the agriculture-based countries of sub-Saharan Africa these shares are still much lower, especially for women. The greater part of the rural labour force is still employed in agriculture and depends on productivity growth within smallholder agriculture to improve their incomes and food security. However, as the rural population pressure is increasing, governments will have to address the rural employment transition here as well.

Projections of the third key determinant of future demand expansion, **income growth**, are subject to greater uncertainty. In the years preceding the recent crisis of 2008/09, economic growth had been particularly high in many developing regions, especially in Asia, but also in many countries of sub-Saharan Africa. The financial crisis has interrupted this growth as a result of a complex set of factors, which need to be addressed systematically to reduce the chances of their recurrence. Although the World Bank predicts growth momentum to turn weakly positive in 2010 and 2011, the pace and timing of the recovery is still highly uncertain and so are the consequences for the longer term outlook.

So far, analysts believe that the **longer-term effects** of the financial and economic crisis on economic growth will be relatively small. Most projections of demand and supply towards 2050 use the World Bank's baseline projections of economic growth. The latest version (submitted to the FAO Expert Meeting in June 2009) implies an average annual rate of GDP growth of 2.9 percent during the period between 2005 and 2050, breaking out into 1.6 percent for high-income countries and 5.2 percent for the developing countries. Over the 45 year period, the rates are expected to decline everywhere to half their initial levels. A key consequence of this differential growth would be a major increase in developing countries' share in global output from 20 to 55 percent. As a result, the relative income gap (ratio of per capita GDP) between the two country groups will be narrowing, although absolute differences would remain pronounced and even increase further, given the current very large gap in absolute per capita incomes. Moreover, inter-country and interregional inequalities within the present-day developing world would tend to become more pronounced.



Source: Mensbrugghe et al. (2009)

The future **growth of food demand** will be the combined effect of slowing population growth, continuing strong income growth and urbanization in many of the developing countries and associated shifts in diet structures, especially in the most populous ones, and gradual food saturation in many developing countries, as is already the case in developed countries. Globally the growth rate of demand will clearly be lower than during preceding decades. Nevertheless, the projected total demand increase is still significant in absolute terms, with only small differences between the main models.

Moreover, it is to be noted, that the **future total demand for agricultural commodities** may exceed the demand for food and feed more or less significantly, depending on the expansion of demand for biofuels and on the technology used for the conversion of agricultural biomass into biofuels. Hence, the development of the bio-energy market will also determine how far it will be possible to meet the growing demand with the available resources and at affordable prices.

How far future growth of incomes and food demand will be adequate to achieve food security will also be determined by the **prospects for poverty reduction.** In this context, it is encouraging to note that the secular decline of global poverty has intensified in recent decades. However progress has not been uniform and apparently it was interrupted during the current crisis. While dramatic improvement was recorded in China and several other large countries such as Indonesia, India, Pakistan, Brazil, Mexico and South Africa. Sub-Saharan Africa as a whole saw a large increase in the number of people living in absolute poverty and only a small decrease in the poverty ratio.

2.2 The natural resource base to 2050 – will there be enough land, water and genetic diversity to meet demands?

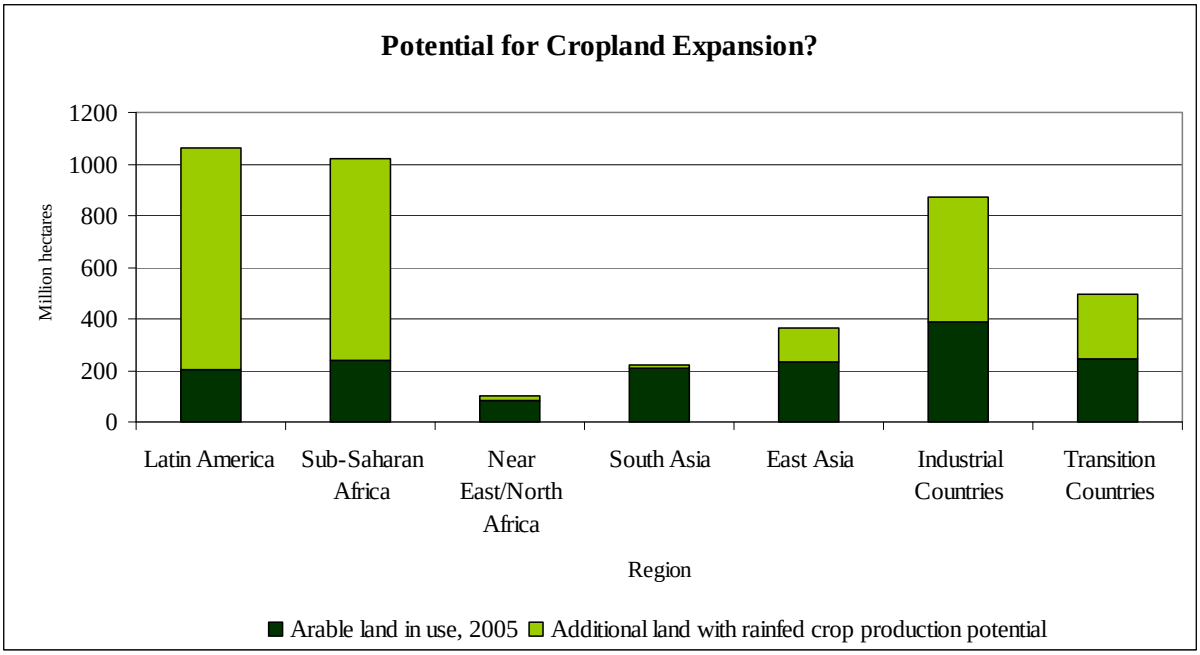
In comparison to the past 50 years, the rate at which pressures are building up on natural resources – land, water, biodiversity – will be somewhat tempered during the coming 50 years due to the slowdown of demand growth for food and feed. However, an expanded use of agricultural feedstock for biofuels and ongoing environment degradation would work in the opposite direction.

Even if total demand for food and feed may indeed grow more slowly, just satisfying the expected food and feed demand will **require a substantial increase of global food production** of 70 percent by 2050, involving an additional quantity of nearly 1 billion tonnes of cereals and 200 million tons of meat. The background to this outlook will be discussed in the following section.

Much of the **natural resource base** already in use worldwide shows worrying signs of degradation. According to the Millennium Ecosystem Assessment, 15 out of 24 ecosystem services examined are already being degraded or used unsustainably. These include capture fisheries and water supply. In addition, actions to intensify other ecosystem services, such as the ecosystem service ‘food production’, often cause the degradation of others. Soil nutrient depletion, erosion, desertification, depletion of freshwater reserves, loss of tropical forest and biodiversity are clear indicators. Unless investments in maintenance and rehabilitation are stepped up and land use practices made more sustainable, the productive potential of land, water and genetic resources may continue to decline at alarming rates.

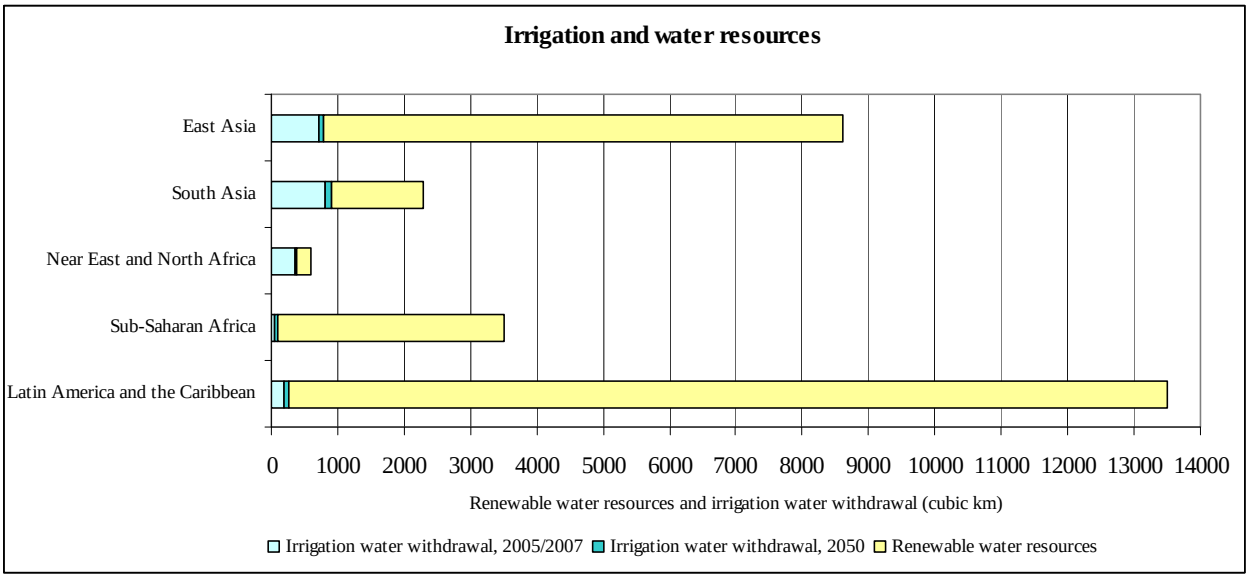
The available long-term perspective studies suggest that assuming such degradation is indeed stopped or significantly slowed, the **natural resource base should be adequate to meet the future demand at global level**. However, bottlenecks are likely to occur at national levels, particularly in countries where high demographic growth and the associated high growth of demand and limited commercial import capacity coincide with pronounced limitations of land or water or particularly low yield levels. If appropriate institutions and incentive systems are instituted, the rural populations of these countries can play a vital role in ensuring an enhanced and sustainable delivery of ecosystem services, thus improving sustainable growth of productivity and incomes locally and generating public goods at national and international levels.

The world has **considerable land reserves** which could in theory be converted to arable land. However, the extent to which this can be realized is rather limited. First, some of the lands currently not cultivated have important ecological functions which would be lost. Second, they are mostly located in just a few countries in Latin America and sub-Saharan Africa, where lack of access and infrastructure could limit their use at least in the short term. Taking these limitations into account, FAO projects that by 2050 the area of arable land will be expanded by 70 million hectares, or about 5 percent. This would be the net balance of an expansion by 120 million hectares in the developing countries and a contraction of arable land in favour of other uses in developed countries by 50 million hectares.



Source: Bruinsma (2009).

The availability of **fresh water reserves** for the required production growth shows a similar picture. At global scale, there are sufficient capacities, but these are very unevenly distributed. Irrigated agriculture covers one fifth of arable land and contributes nearly 50 percent of crop production. Hence, it is extremely productive. An increasing number of countries are reaching alarming levels of water scarcity and 1.4 billion people live in areas with sinking ground water levels. Water scarcity is particularly pronounced in the Near East/North Africa and the South Asia regions and is likely to worsen as a result of climate change in many regions. While supplies are scarce in many areas, there are ample opportunities to increase water use efficiency.



Source: Bruinsma (2009)

Biodiversity, another essential resource for agriculture and food production, is threatened by urbanization, deforestation, pollution and the conversion of wetlands. As a result of agricultural modernization, changes in diets and population density, humankind increasingly depends on a reduced amount of agricultural biological diversity for its food supplies. The gene pool in plant and animal genetic resources and in the natural ecosystems which breeders need as options for future selection is diminishing rapidly. A dozen species of animals provide 90 percent of the animal protein consumed globally and just four crop species provide half of plant-based calories in the human diet.

FAO expects that globally 90 percent (80 percent in developing countries) of the growth in crop production will come from intensification, in particular higher yields and increased cropping intensity. This would be in line with past trends, but represents a major challenge for future private and public research, including research for greater resilience of farming systems.

The future of agriculture and the ability of the world food system to ensure food security for a growing world population are closely tied to **improved stewardship of natural resources**. Major reforms and investments are needed in all regions to cope with rising scarcity and degradation of land, water and biodiversity and with the added pressures resulting from rising incomes, climate change and energy demands. There is a need to establish the right incentives to harness **agriculture's environmental services** to protect watersheds and biodiversity and to ensure food production using sustainable technologies.

Even if globally the natural resource capacity may be adequate to achieve the 70 percent increase in agricultural production needed to meet projected demand (without biofuels), **bottlenecks exist at national levels**, namely in countries with high demand growth, fragile environments and limited commercial capacity to import food or feed from the world markets. In order to ensure that resources are available in the required quantity and quality and in the locations where they are needed, large additional investments need to be made. Priority

should be given to interventions in favour of agriculture-dependent countries in which high prevalence of hunger coincides with resource scarcity and low yields.

Increased investment, **effective regulation and incentives are needed with regard to all three natural resources** required for sustainable and stable production growth: land, water, biodiversity. The aim should be to stop over-exploitation, degradation and pollution, promote efficiency gains and expand overall capacities as appropriate. Adequate regulation and incentives are also needed to provide the rural population engaging in ecosystem services with win-win solutions to improve the sustainability of ecosystems, mitigate climate change and improve rural incomes.

2.3 Potential for food security

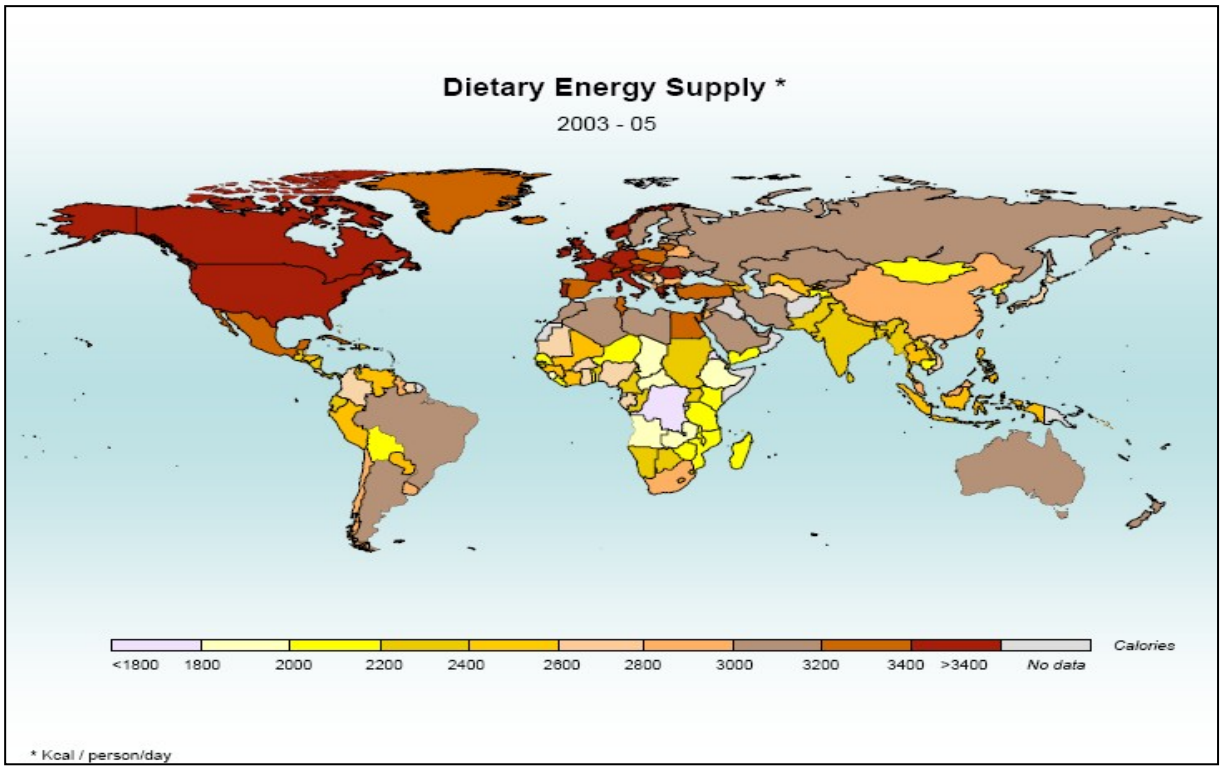
The projections for the future socio-economic environment and the assessment of the situation and prospects of the natural resource base raise the question as to whether and under what conditions the estimated future food demand can be met and how food security can be achieved.

Based on the projected growth of population and incomes and expected changes in consumption patterns, the FAO estimates future consumption levels for various commodities country by country. Taking into account countries' known resource capacities and projected development of yields, input use and technologies, and making assumptions about their future trading capacity, estimates are also made of future production levels, land use and trade. At the same time, on the basis of available information concerning the distribution of incomes and access to food within countries, the future prevalence of hunger is estimated in terms of the proportion of populations not having access to an adequate level of food energy. FAO's long-term perspective studies thus seek to assess the implications of the projected socio-economic and demographic environment for future demand growth and to ascertain the extent to which individual countries and the world as a whole can meet this demand through production and trade and improve food security, based on reasonable assumptions about resource and productivity growth potentials.

According to **FAO's baseline projections**, it should be possible to meet the future food and feed demand of the projected world population in 2050 within realistic rates for land and water use expansion and yield development. However, achieving this will not at all be automatic and several significant challenges will have to be met.

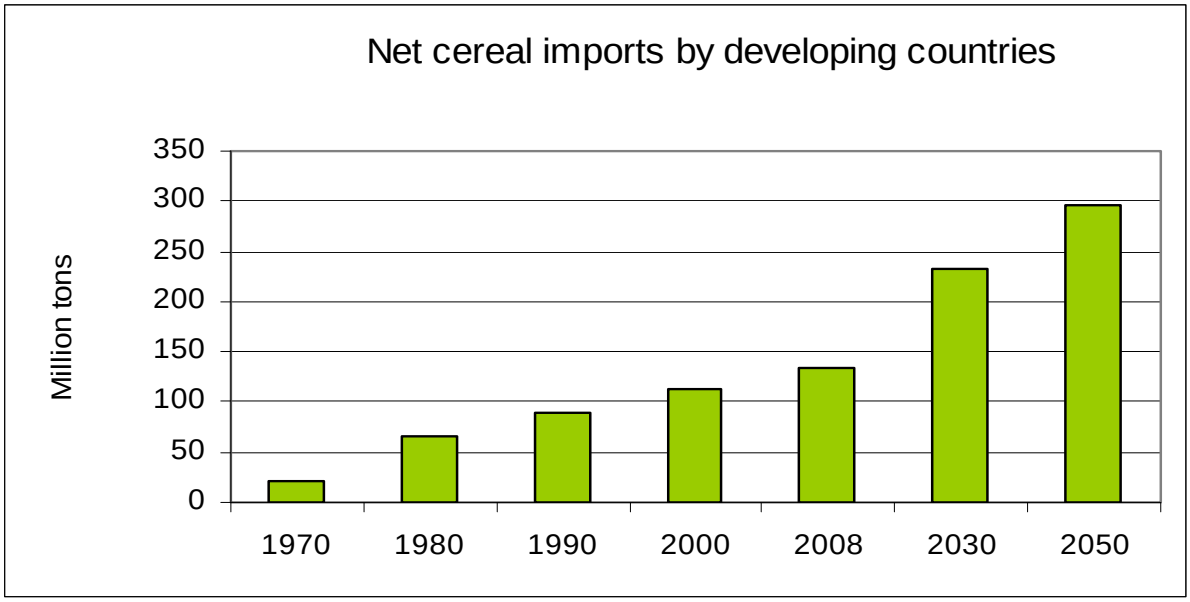
The **global average daily calorie availability** would rise to 3050 kcal per person, a 10 percent increase over its level in 2003/05. To achieve this, global cereal production would need to increase by 40 percent overall, or by some 900 million tons between the 2006/08 average and 2050. The advent of biofuels has the potential of changing all that and causing world demand to be higher, depending on the energy prices and government policies. Without biofuels, much of the increase in cereals demand will be for animal feed to support the growing consumption of livestock products. Meat consumption per caput for example would rise from 41 kg at present to 52 kg in 2050 (from 30 to 44 kg in the developing countries).

Should this perspective be realized by 2050, the level of per-caput **food availability will still vary widely between countries,** although at higher levels. Industrial countries will have average availability levels of nearly 3600 kcal/person/day; the developing countries as a group may reach almost 3000 kcal.

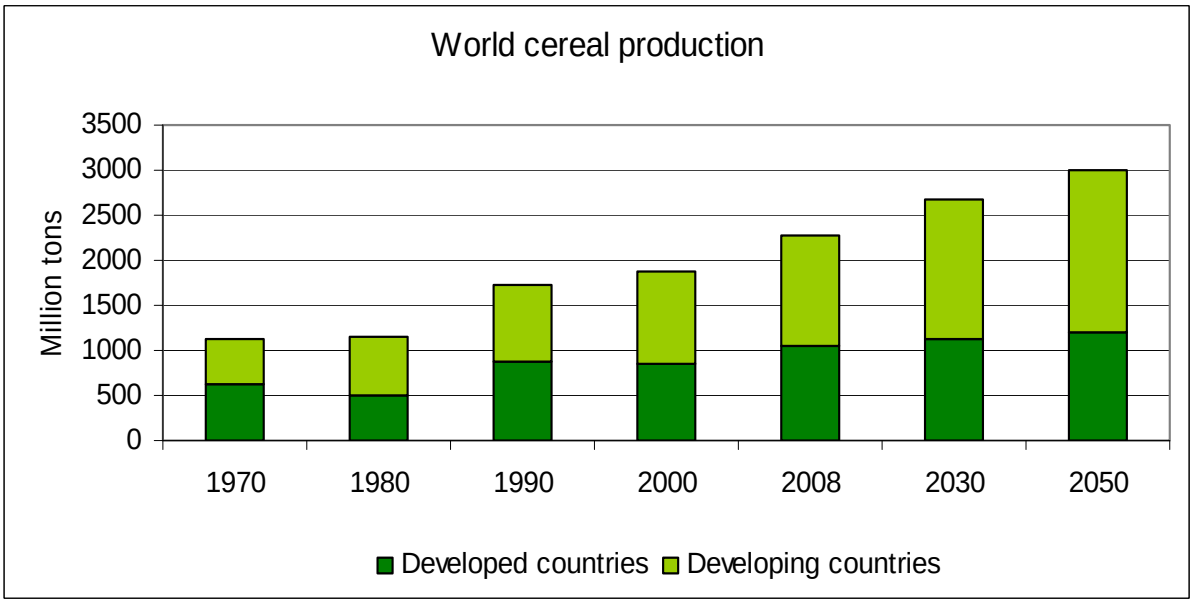


Source: FAO

To reach those levels of food availability, countries can **either increase production or increase net imports** of food or a combination of both. According to FAO's long-term projections towards 2050, today's group of developing countries is projected to provide most of the projected consumption growth by expanding their own production. However they will also increase their food imports significantly. For example, the developing countries' net imports of cereals are projected to more than double from 135 million metric tons in 2008/09 to 300 million metric tons in 2050. The developed countries will be able to increase their export potential accordingly. On their part, the developing countries will be growing net exporters of other food commodities like vegetable oils and sugar. Again, the advent of biofuels has the potential of altering these prospects as all three commodity groups are used as biofuel feedstocks.



Source: FAO (2006)



Source: FAO (2006)

Even if the intra-national distribution of incomes and purchasing power does not change significantly, the projected rather high average levels of food availability would imply that the **prevalence of chronic hunger** may recede considerably in most countries and problems related to over-nourishment may become an issue in more countries.

But unless there is a major shift in policy priorities hunger will not disappear. Considering only the prospects for supply and demand for food and feed (as expressed in the market), and excluding any eventual growth in demand for biofuels, the prevalence of chronic under-nourishment in developing countries would decline to about 5 percent of their population by 2050. Five percent of the developing countries' population in 2050 would still be 370 million people, an unacceptably high number. Moreover, the average hides differences between countries. Sub-Saharan Africa as a whole would still be at 7 percent and some smaller countries could still have prevalence rates over 15 percent. For almost 400 million people even the projected 70 percent growth in output of food and feed (and eventually the additional

volume of feedstock for biofuels) will not guarantee that they have access to adequate food. Their access to food will require a proper socioeconomic framework to address imbalances and inequalities. Extra efforts of public policy will be needed, be it in terms of additional productive employment inside or outside agriculture, structural reforms creating a more equitable income distribution or targeted social safety nets. Moreover, food production must be carried out in a way that reduces poverty and takes account of natural resource constraints.

IFPRI's long-term projections also indicate the possibility of significant improvements in the prevalence of pre-school child malnutrition, though not as far and with considerable inter-regional differences. South Asia and large parts of sub-Saharan Africa would maintain a relatively high prevalence.

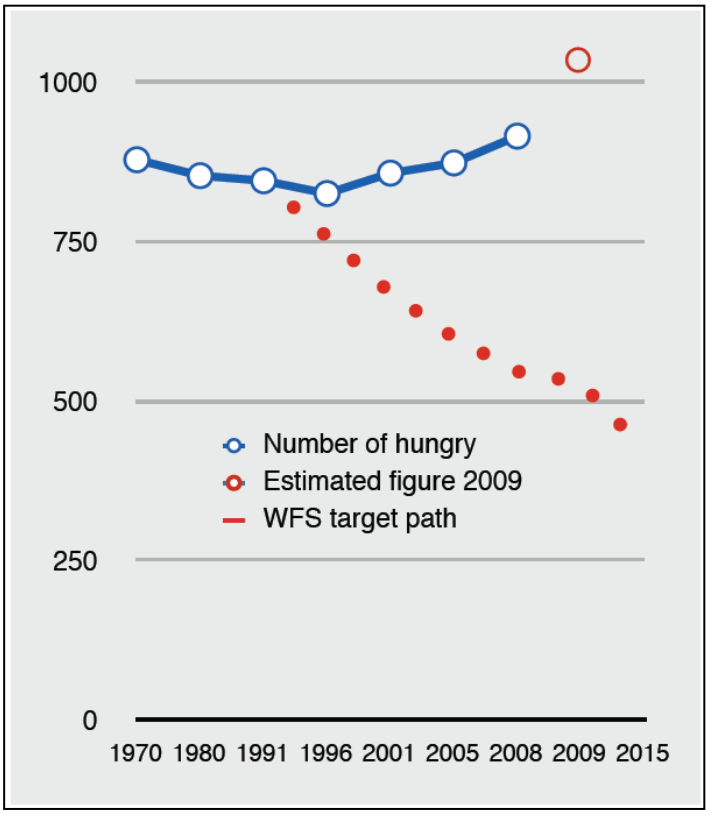
In conclusion, under the assumptions made for the baseline modelling of the outlook towards 2050, **food security** for all could be within reach. The conditions under which this can be achieved are strong economic growth, global expansion of food supplies by about 70 percent, relatively high production growth in many developing countries achievable through growing capital stock, higher productivity and global trade helping the low income food deficit countries to close their import gaps for cereals and other food products at affordable prices.

It should be underlined, however, that these projections do not yet take into consideration the possibility of a more intensive **competition between food and energy commodities** for the limited land and water resources. As the recent crisis has demonstrated, under certain conditions (high oil prices, first generation biofuel technologies, government support in several countries), the production of biofuels can expand rapidly and contribute significantly to price increases and scarcities in the food and feed markets.

It is obvious that the positive vision presented here contrasts strongly with the reality of recent trends. **The number of chronically undernourished and malnourished people in the world has been rising, not falling.** FAO estimates that the number of chronically undernourished people has risen from 842 million at the beginning of the 1990s to over one billion in 2009. The recent increase was mainly the consequence of the recent financial crisis and the drastic food price increases and occurred although harvests had reached record levels.

The existence of hunger in a world of plenty is not only shameful and a violation of the human right to adequate food, **hunger and malnutrition also entail large economic costs**, severely compromising the productivity of individuals and, when more than 30 percent of the population are chronically undernourished as in many African countries, the growth of entire economies. In 2002, FAO estimated that, compared to business-as-usual, achieving the WFS goal of cutting by half the number of hungry people by 2015 would generate global annual incremental benefits of USD 120 billion during the period up to 2015.

The world is not on track towards the global goal of hunger reduction - number of hungry in millions



Source: FAO (2009)

It is noted that **a considerable number of developing countries have been successful in improving food security**. The common characteristics of their policies and strategies include political stability, good governance, strong economic growth, very much based on growth of agriculture in several of these countries, twin-track food security strategies and integration into world markets. Unless food security is made a high priority of public policy in more countries, those that are still faced with low food consumption levels and high prevalence of chronic under-nourishment may face the prospect of food insecurity persisting for a long time to come.

3. Pre-requisites for global food security

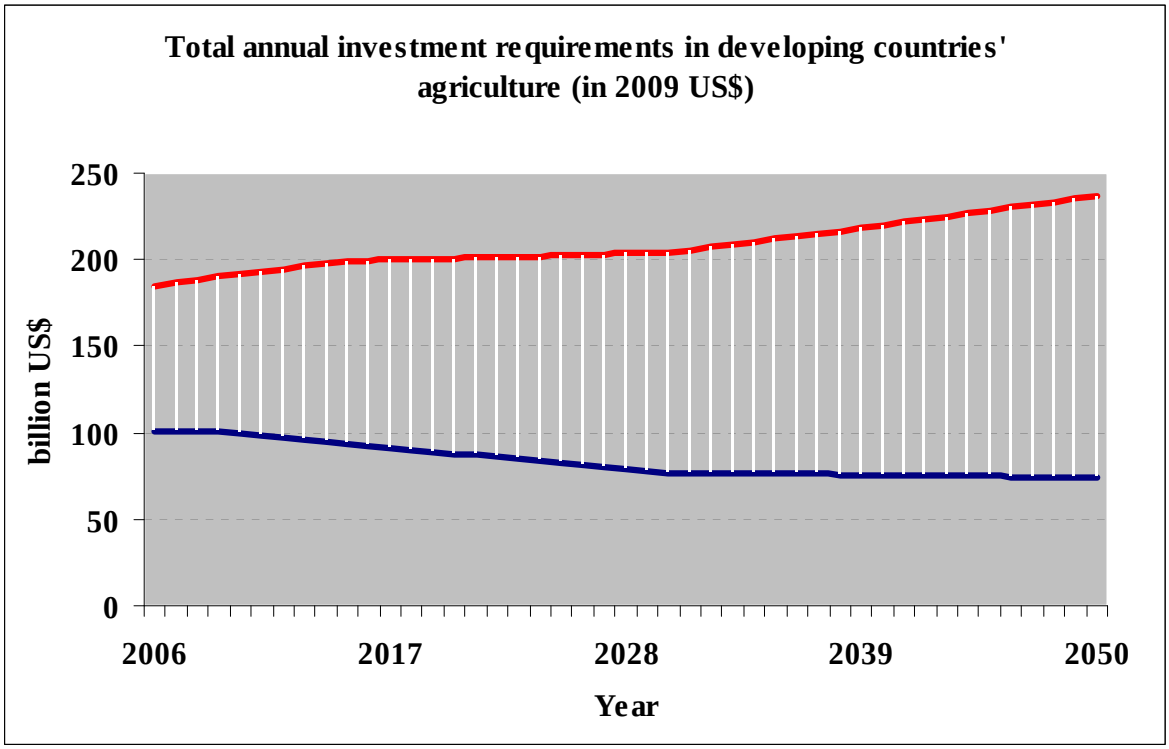
Action is needed now to ensure that the required 70 percent increase in food production is achieved, and that every human being has access to adequate food. First, investment in developing country agriculture has to increase by at least 60 percent over current levels through a combination of higher public investment and better incentives for farmers and the private sector to invest their own resources. Second, greater priority has to be given to agricultural research, development and extension services in order to achieve the yield and productivity gains that are needed to feed the world in 2050. Third, global markets have to function effectively as food security for an increasing number of countries will depend on international trade and access to a stable supply of imports.

3.1 Enhancing investment in sustainable agricultural production capacity and rural development

Developing countries, in particular those with a high prevalence of hunger should **create conditions for a gradual increase of investments** in primary agriculture, up- and downstream sectors and rural infrastructure.

A key question confronting governments, farmers and the private sector at large is which **level and composition of investment** will be required to achieve the production needed to meet future demand. Related is the question whether the past and current trend of actual investment corresponds to those requirements. Several institutions have presented estimates of actual and required investment in agriculture.

FAO's experts, using a unit cost approach, have estimated total **capital requirements in developing countries needed to achieve future production levels** consistent with FAO's baseline long-term outlook for global agriculture in 2050. The estimates cover most capital items in primary agriculture and downstream support services, without distinguishing public versus private sources. According to these estimates, total average annual net investment required to deliver the projected production increases would amount to USD 83 billion, or an average gross investment, including the cost of renewing depreciating investments, of USD 209 billion, at constant 2009 prices. Of this, net investments in agriculture would amount to USD 83 billion net per year on average. These estimates exclude an eventual increase in demand for feedstock for biofuels.



Source: Schmidhuber et al. 2009

The global gap in what is required vis-à-vis current investment levels can be illustrated by comparing the required annual gross investment of US$209 billion (which includes the cost of renewing depreciating investments) with the result of a separate study that estimated that

developing countries on average invested USD 142 billion (USD of 2009) annually in agriculture over the past decade. The required increase is thus about 50 percent.

There is empirical evidence that insufficient investment in agricultural production of developing countries can have a severely **detrimental impact on their food security**. Recent research results show that, indeed, the agricultural capital stock per person active in agriculture has grown least in those countries with the highest prevalence and depth of hunger. In countries with more than 20 percent of the population undernourished, growth in the agricultural capital stock has been outstripped by population growth, resulting in a reduction in the level of capital per person active in agriculture. The same is true for countries with a particularly high depth of hunger. Investments have been particularly low and the capital-labour ratios have been declining in countries of sub-Saharan Africa and South Asia with the highest prevalence and depth of hunger. Unless higher investments are made, the majority of the poor in these countries cannot introduce technical change and increase labour productivity.

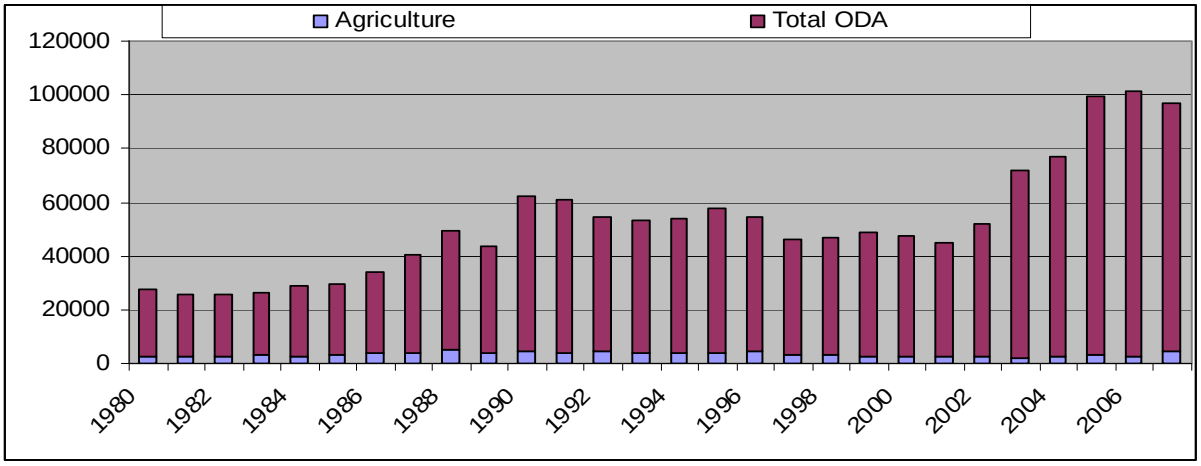
A related study presented by IFPRI, using a unit cost approach, calculated incremental public **investment requirements to achieve Millennium Development Goal Number One** of halving the proportion of poor and hungry people by 2015 in all developing countries. The IFPRI estimate, covering agricultural research, irrigation and rural roads, amounts to USD 28.5 billion per year, which would actually double the amount of a baseline scenario. The authors underline that achieving MDG1 will also require additional investments in complementary services, such as secondary female education and access to clean water.

Future investments are expected to support a growing **substitution of labour with capital and moderate total factor productivity growth**. There would be marked regional differences, however. In sub-Saharan Africa, for example, agriculture would remain dependent on labour-intensive, capital-saving forms of small-scale agriculture and investment in irrigation will be particularly important.

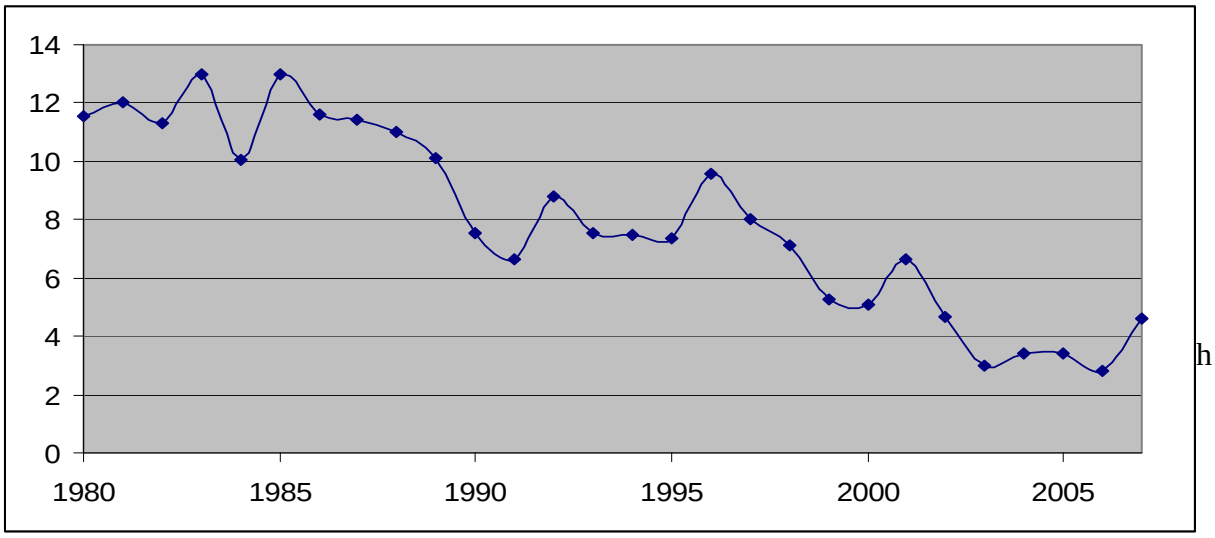
Government expenditure on agriculture, focusing on transportation and market infrastructure, on research and/or irrigation, is positively correlated with capital formation. It strengthens incentives for the private sector, in particular farmers, to invest in productive assets. It has been shown that while the level of government expenditure may have a significant effect, changes in the composition of such expenditures, for example from subsidy payments to expenditures on public goods, may have a much more significant effect on rural incomes and income distribution.

The need to significantly increase the volume of **Official Development Assistance (ODA) for agriculture and rural development** has been underlined by various international organizations and at highest political levels. ODA can enhance the effectiveness of public funding. Given the common purpose of public resources from domestic and from international sources, both could be made complementary through effective coordination and joint targeting and monitoring in line with the Accra Agenda for Action. To create stability, and as a matter of equity, developed countries could consider a proposal made at the Expert Meeting in June 2009 to pledge additional ODA to agriculture at the level of a given share of

Official Development Assistance 1980 – 2007 (USD million)



Proportion of total ODA on Agriculture 1980 – 2007



Source: OECD

Countries need to **improve the rural investment climate** through improvements in institutions, stability and transparency. There is also a need to increase public investments in rural areas of developing countries. Public investment has a decisive role in generating a supply of public goods which is conducive for private investment and for improving smallholder technology.

Foreign Direct Investment (FDI) in agriculture, forestry and fishing has been less dynamic than FDI in other sectors. However, more recently, investors of different size and corporate structure have become active at all points in the global value chain, from input supply, seed propagation, production on the farm, basic processing, trading and logistics, processing and retailing. There had been a significant increase in the food and beverage sector in the last few years. The main products targeted by trans-nationals included corn, cotton, dairy products, floriculture and fruits, meat and oil crops, rice, soybeans, sugar-cane, vegetables and wheat.

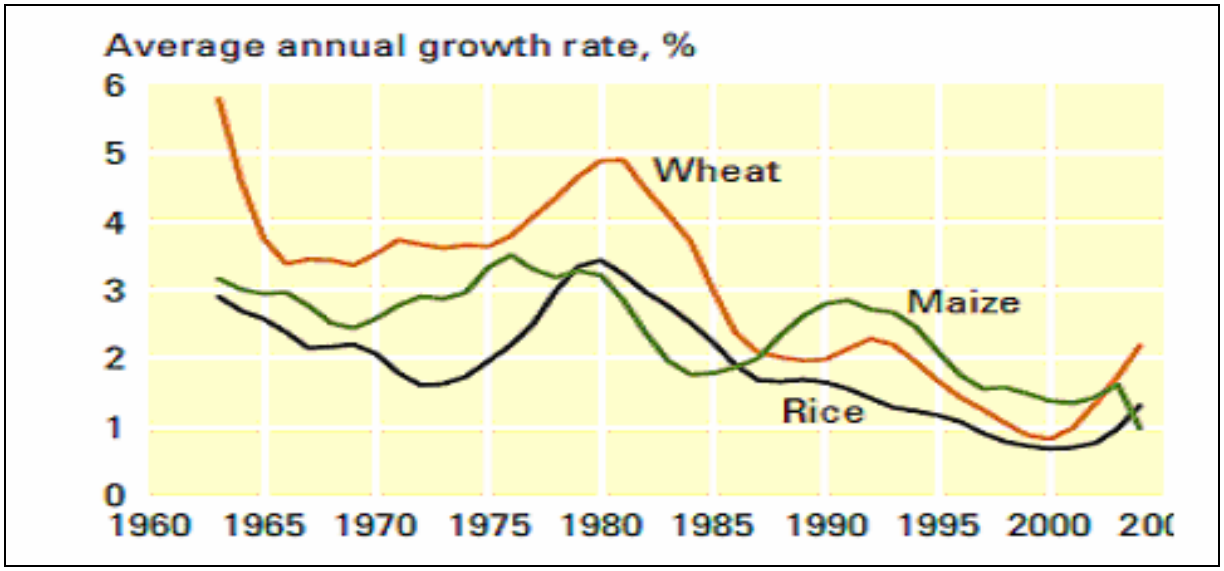
Most of the investing companies have been based in United States and Europe, but also some North African and Middle Eastern countries, China and South Africa.

Foreign investors seem to be particularly interested in making **direct investment in land**, either through outright ownership or long-term leases. Purchases and leasing of agricultural land in Africa by foreign investors for food production in support of their food security strategies has attracted most attention recently, but it is only one of a variety of actual or planned investment flows. This development involves complex and controversial issues – economic, political, institutional, legal and ethical – that need to be addressed by policy-makers. These relate to effects on food security, poverty reduction, rural development, technology and access to resources, especially land. Developing countries also need to improve their capacity to **manage the process of foreign investment** in land and processing industries. The policy of the host country is critical in determining the rules for such investments, including standards for short, medium and long-term contract farming arrangements and the form of land tenure. The possibility of an international Code of Conduct could be explored in this rapidly changing field.

3.2 Promoting technology change and productivity growth

World agriculture has been able to meet the rapidly growing global demand for food, feed and fibre over the last half century at real agricultural prices that were falling for much of the time, at least until the mid-80s. This was only possible due to sizeable **agricultural productivity growth**. However, in recent years, yield growth rates have slowed down notably in many countries and for major commodities. In particular, the growth rates of cereal yields have been falling since the Green Revolution years. It dropped from 3.2 percent per year in 1960 to 1.5 percent in 2000.

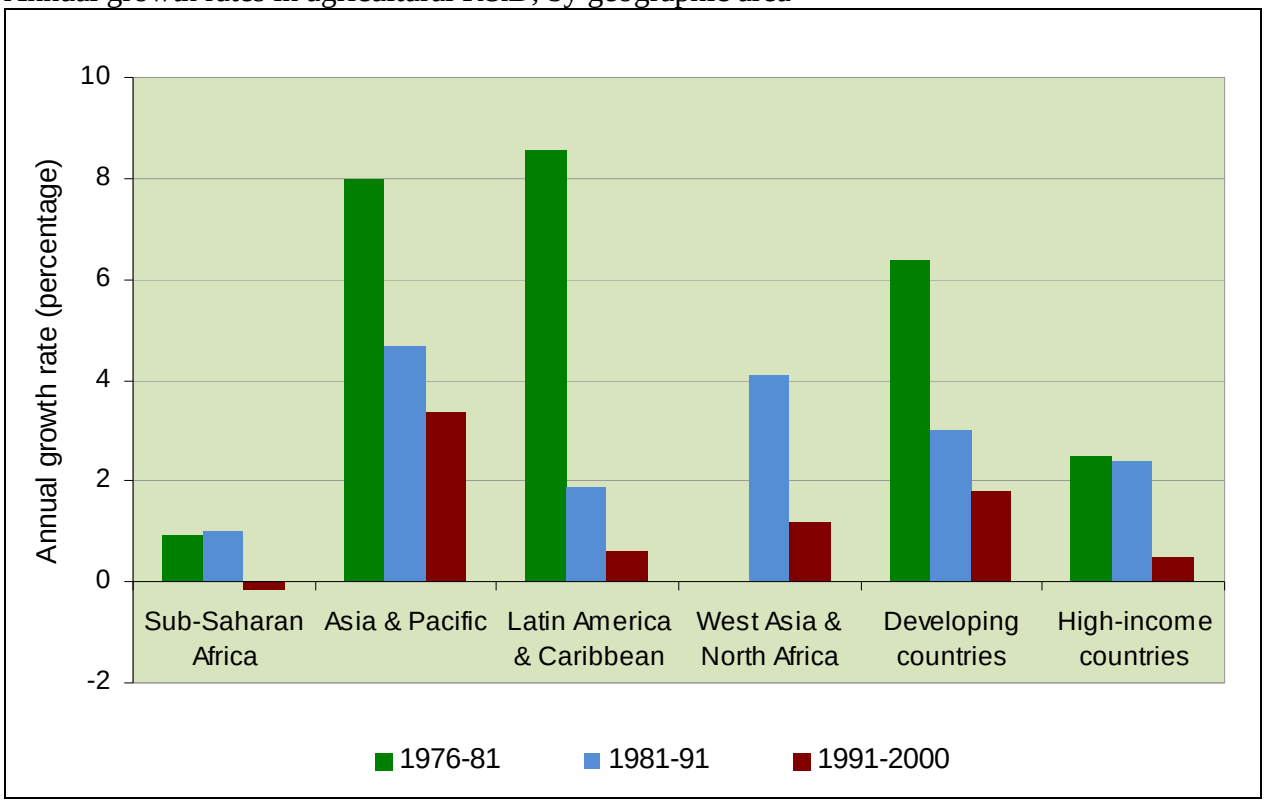
Growth rates of yields for major cereals, 1960 - 2000



Source: World Bank (2008)

Numerous studies have shown that investment in **agricultural research and development (R&D) can generate extraordinary high rates of return**. Nevertheless, under-investment in agricultural R&D in many developing countries has continued. Total global investment in agricultural R&D totaled USD 41 billion in the year 2000. The public sector accounted for 59 percent and the private sector 41 percent. Most private sector research was carried out in developed countries and tended to be focused on the requirements of commercial farmers in well-developed regions. Public sector R&D still dominates in developing countries and is more focused on basic research and the improvement of staple food and minor crops. Public investments in agricultural R&D worldwide grew from USD 16 billion in 1981 to USD 23 billion in 2000. There were large differences between and within regions: While public investments in the Asia-Pacific (driven by China and India) region more than doubled over this period, investments sub-Saharan Africa only grew at an annual average of 0.6 percent from 1981 to 2000 and actually fell during the 1990s. Agricultural R&D investments are increasingly concentrated in a few leading countries in each region.

Annual growth rates in agricultural R&D, by geographic area



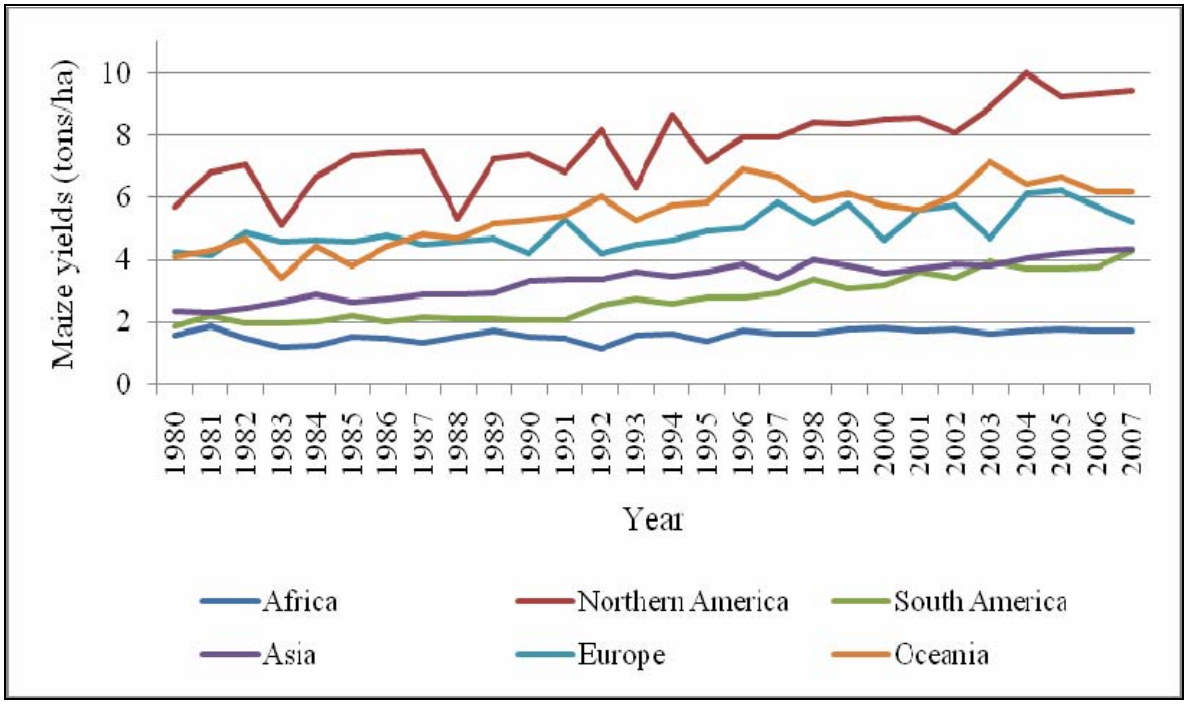
Source: Beintema and Elliott, 2009

Low levels of private investment in research are sometimes explained by market failure to appropriate the benefits from private investment in small markets. However, such situations, which are typical for many small countries and commodities with limited geographical spread, should be even more reason for strong public investments in agricultural research, both with national and international funding. Where countries are small, international cooperation in concrete R&D projects can provide significant scale economies. In particular, the CGIAR needs to be further strengthened. In order to encourage private sector investment in breeding and seed systems, plant breeding intellectual property rights need to be clearly defined.

The **suite of technological options should be as broad as possible**, ranging from new plant varieties and animal breeds better adapted to changing conditions; to farming systems with improved water- and labour-saving technologies; reduction of losses and waste; and natural resource management. Technological advances are particularly needed in the staple crop sector. Preference should be given to technologies promising **win-win combinations** of enhancing productivity and sustainability managing natural resources, for example conservation farming approaches based on no tillage.

It is not enough to ensure that future yields are high in some high-potential countries which can export surpluses to deficit countries. Rather, improvement of productivity and resilience of production systems is of particular importance in **countries with limited import capacity** and, within countries, in those areas where productivity growth in agriculture is essential for raising rural incomes, improving access to food for the poor and enabling local agriculture to compete better with low-price food imports.

Variant progress in maize yields, 1980 – 2007



Source: FAOSTAT

Even at current levels of technology**, large and economically exploitable yield gaps** remain in many places. In sub-Saharan Africa, in particular, there are indications of yield gaps which could be exploited with given varieties and with known practices. Cereal yields in Africa have grown little and are still at around 1.2 tonnes per hectare, compared to an average yield of some 3 tonnes per hectare in the developing world as a whole. Fertilizer consumption was only 13 kg per ha in sub-Saharan Africa in 2002, compared to 73 kg in the Middle East and North Africa and 190 kg in East Asia and the Pacific.

There are many **reasons why yield gaps exist**. One is that farmers do not have sufficient economic incentives to adopt yield enhancing seeds or cropping techniques. This may be explained by numerous factors, including lack of access to information, extension services and technical skills. Poor infrastructure, weak institutions and discouraging farm policies can also create huge obstacles to the adoption of improved technologies at farm-level. Other factors can be that available technologies have not been adapted to local conditions. Solutions lie with public sector investments in infrastructure and institutions, and sound policies to stimulate adoption of technologies that reduce costs as well as improving productivity, thus increasing agricultural incomes. Changes in crop management techniques can also help closing yield gaps. Plant breeding plays an important role in closing yield gaps by adapting varieties to local conditions and by making them more resilient to biotic (e.g. insects, diseases, viruses) and abiotic stresses (e.g. droughts, floods). Studies estimated that the global yield loss due to biotic stresses averages over 23 percent of the estimated attainable yield across major cereals.

The technology challenge also extends to the **up- and downstream sectors**. Transforming developing economies in particular need research and extension services to ensure that traders, processors and distributors have access to a broad choice of technologies that are competitive and comply with food safety and quality standards.

In 2008, genetically modified crops were cultivated on 800 million hectares in 25 countries (15 developing and 10 developed countries). Herbicide tolerant soybeans are the major genetically modified crop, occupying 53 percent of the totally area under genetically modified crops, followed by maize (30 percent), cotton (12 percent) and canola (5 percent). So far, the acceptability of transgenic crops continues to be controversial in many societies, including those of developing countries. In others, the related trade risks are considered too high. To date, many developing countries do not have the technical and regulatory capacity to assess the benefits and costs of modern biotechnology in their domestic agriculture and eventually to monitor the inclusion of transgenic crops in their agriculture. However, some major developing countries (China, Brazil, India) have been making great strides in agricultural R&D.

Spreading knowledge, skills and technology is a major challenge. In many countries, extension services have been cut, in others the knowledge base and extension services have been hard hit by HIV-AIDS. Agricultural extension programmes are meant to ensure that information on new technologies, plant varieties and cultural practices reaches farmers. In many regions of the developing world, women form the majority of farmers, which means particular efforts need to be made to factor the needs of women into dissemination and capacity development programmes. However, in the developing world it is common practice to direct extension and training services primarily toward men. A recent FAO survey showed that female farmers receive only five percent of all agricultural extension services worldwide and that only 15 percent of the world's extension agents are women. Policies have been based on the assumption - proved wrong by studies - that information conveyed to the male head of a household would be passed on to its female members. Apart from extension services, Farmer Field Schools are proving an effective means to spread knowledge, while information and communication technologies (ICTs) also look very promising tools for information dissemination.

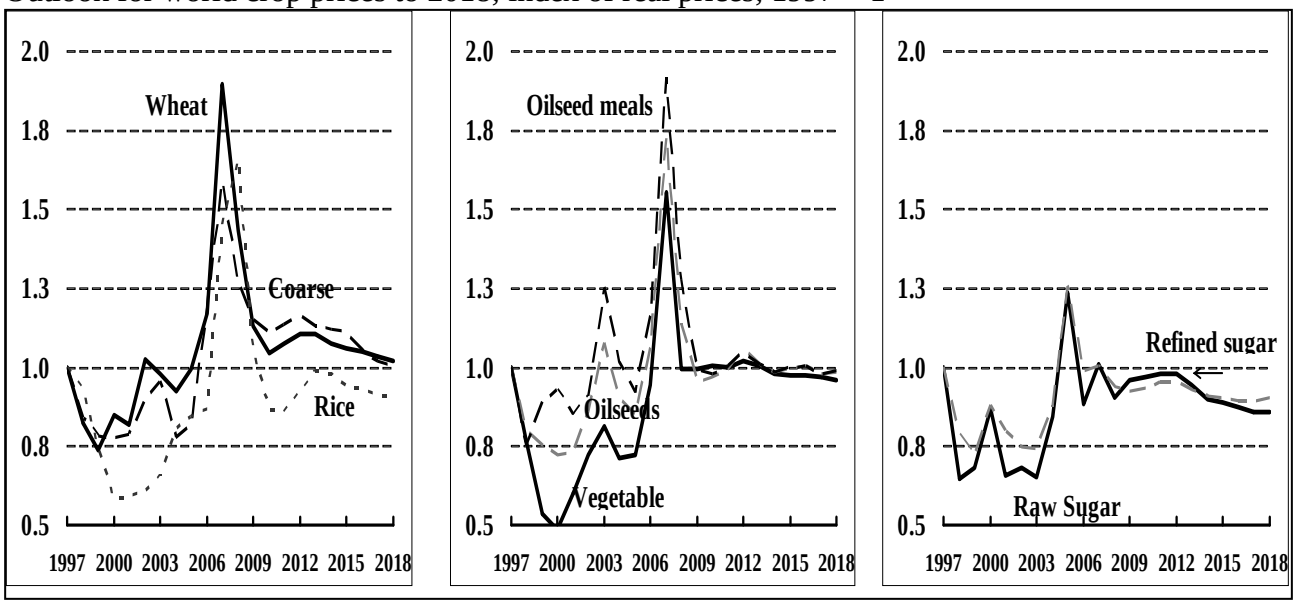
3.3 Trade, markets and support to farmers

The recent world food crisis of 2007-2008 provided a clear reminder that the global food and agricultural system, including current national agricultural trade policies and world trade rules, is highly vulnerable. The **risks associated with this vulnerability and with the realistic possibility of a re-occurrence of extraordinary price spikes and scarcity on world markets** necessitate, *inter alia*, a reconsideration of the factors that drive long-term agricultural trade, including a possible reform of the global agricultural trade rules.

As is well known, real world market prices of major cereals, oilseeds, vegetable oils and livestock products had been on a declining trend over the past 30 to 40 years. However, the rate of decline had slowed, and not just recently, but since the early 1990s. In fact, a number of factors seem to have gradually created a **situation of tightly balanced supply and demand**: growing world demand, especially in developing countries, for basic food as well as high value commodities; slowing rates of productivity growth; rising energy prices and conversion of agricultural feedstock into biofuels. Under such tightening conditions, it may take just a single shock such as a crop shortfall, commodity speculation or a short-term energy price increase to create a major price spike. The recent spike involved all three and was further aggravated by policies such as export restrictions or bans, through which various countries tried to keep their domestic prices low in favour of their own consumers.

The **medium to long-term outlook for agricultural commodity prices** will be determined by the prospects for the continuation of the major factors that contributed to the tightening of markets. Whereas overall demand growth is expected to slow further globally, demand for some income-sensitive products will grow faster, in particular in developing countries. This could keep the demand-supply balances tight. Insufficient investment in productive capacity, including research for faster productivity growth in the developing countries, would keep supply elasticity low and markets tight. Another factor which may keep prices firm in the medium term is further demand growth for biofuels. In conclusion, available mid-term to longer-term projections, for example by OECD/FAO and IFPRI, indicate that prices may stay above pre-2006 levels, at least in the medium term.

Outlook for world crop prices to 2018; index of real prices; 1997 = 1



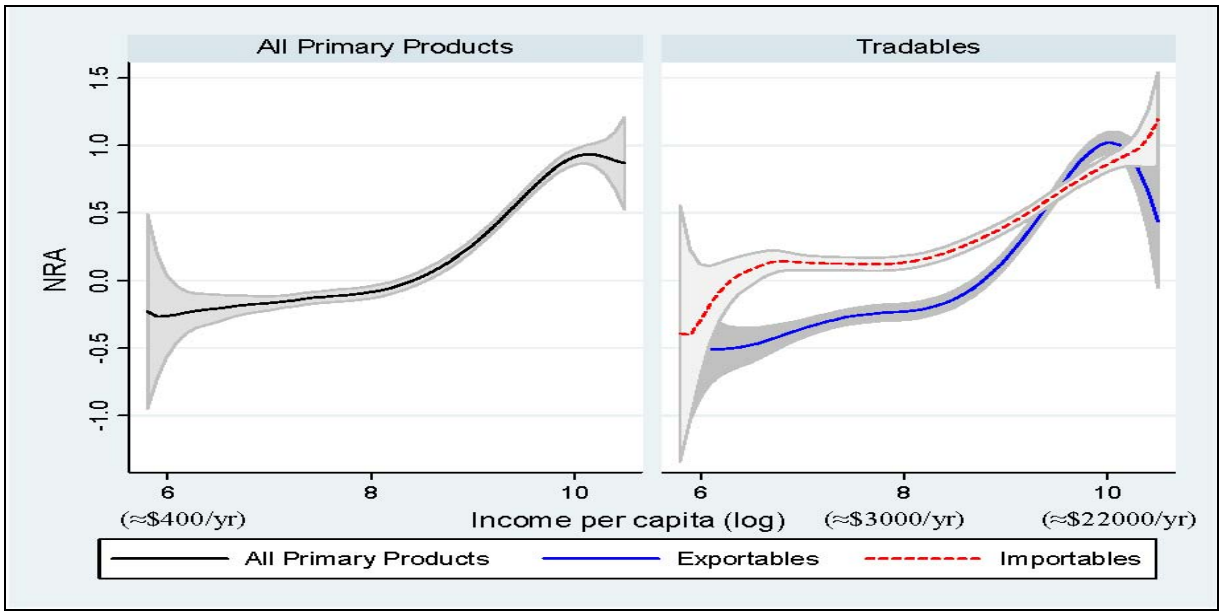
Source: FAO-OECD Outlook (2009)

Several factors point to the **risk of growing price volatility**. The first, production variability, certainly contributed to the recent spike, but has generally become less and less pronounced at global level in recent decades. Other drivers of price volatility include the instability of the US dollar exchange rate, macroeconomic instability, unstable oil prices and inward-looking country policy reactions to certain world market events, such as export constraints in times of high prices. The overall conclusion is that global food commodity markets are likely to stay volatile in the foreseeable future.

Low-income food deficit countries need to reduce their vulnerability to international market shocks - and this preferably not through erection of new trade barriers but through investment in productive capacity and risk management. So long as they do not succeed in improving their overall economic and socio-political stability, they are likely to remain dependent on short-term external assistance. Many of them, especially LDCs in Africa, have become more food-import dependent without becoming more productive in their own agricultural producing sectors, or without expanding other export sectors to be able to counteract their import dependency. As a result, they have become more exposed to international market instability with the result that poor households are extremely vulnerable to the risk of short-term increases of prices of basic food stuffs.

In recent years many developing countries have improved price incentives for agricultural producers by reducing historical policy biases against agriculture. In developing countries farm policies have been driven largely by the need to accelerate a transition from low income agrarian structures to more developed industrialized and service-oriented economies. At early stages of this transition the policies adopted usually aimed at keeping food prices and hence wages low. The overall effect of such policies, as measured by Nominal Rates of Assistance (NRA), that have been computed for a large number of countries and products in a recently completed World Bank project on agricultural distortions, has been largely to tax agricultural producers (namely negative NRAs). In the process, the agricultural sectors in many countries have faced negative policy biases, low growth rates, and high poverty incidence, while inducing increasing import dependence. At later stages of the transition, namely when average incomes grow (typically at a per capita income level of USD 8000 or more), and the share of farmers in total employment declines, the farm support policies in developing countries seem to turn positive and follow patterns similar to those of now developed countries, namely NRAs increasing as the share of agriculture in the economy declines and average agricultural and total incomes increase

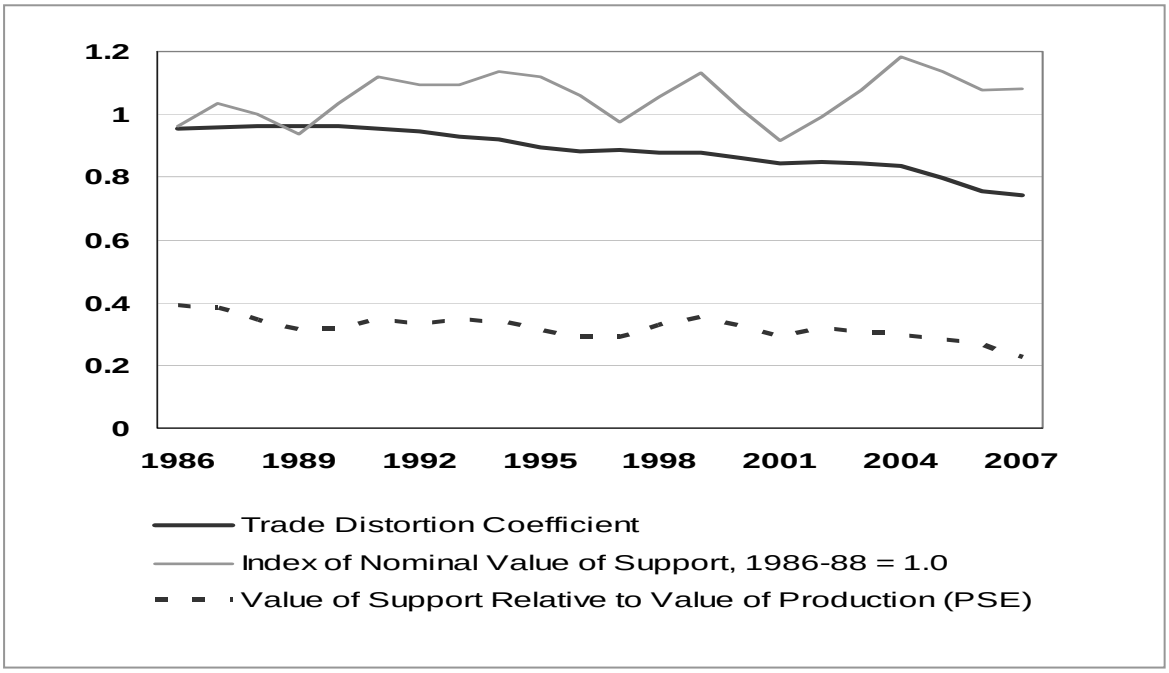
Relation between nominal rates of assistance in agriculture and per caput incomes in developing countries



Source: Masters 2009

While overall **OECD support to farming** has been stable over time, periodic reforms since the onset of the Uruguay Round have changed the relative weight of different policy instruments, with increased reliance on decoupled support. According to OECD, from 1986-87 to 2005-07, the value of OECD agricultural production increased by 53 percent while total producer support increased by 10 percent. The ratio of producer support to the value of production declined from 40 to 29 percent. Market price support and payments based on output have decreased. Combined, support based on commodity output accounted for 82 percent of total support in 1986-88; in 2005-07 it accounted for 55 percent. Consequently, the aggregate trade-distortion coefficient for OECD agricultural support declined from 0.96 in 1986 to 0.74 in 2007.

OECD Agricultural Support, 1986 – 2007



Source: Skully (2009)

Payments based on area, historical entitlements, input constraints, and total historical farm income are decoupled from current production decisions and hence have a lesser impact on production and trade. The decoupled payments can also be viewed as an exit strategy from farming for many developed country farmers. Decoupled policies could include not only support for land set-asides, but also support for technology and farm human capital skills, incentives to maintain set-aside land in production ready and environmentally sustainable condition and other similar policies, and could be a powerful alternative to physical and very expensive commodity reserves, which are not only hard to organize, but also very questionable in their effectiveness. Productive land set-aside can be brought into physical production in high-income countries within 6 to 10 months (the recent supply response is evidence to that), providing a powerful reserve to any future food shortages, while at the same time not distorting current global markets with overproduction.

There is a need to move towards a **global trading system that contributes to a dependable market for food, feed and fibre**, focuses on eliminating trade barriers and ensures that safety mechanisms are in place to shield the most vulnerable. At the international level, countries need to consider joint measures to be better prepared for future shocks to the global system, for example through coordinated action in case of low food stocks, reform of trade rules, joint finance to assist people affected by a new price spike or localized disasters.

As price spikes could become more frequent, the understandable **concerns of import-dependent countries** need to be addressed. Appropriate arrangements are needed to ensure access to adequate food imports by low income net food importing countries in situations of extraordinary shortfalls of supplies and high prices on global markets. Such arrangements could include suitable risk reduction and risk coping policies and/or a dedicated food import financing facility. Policies such as export bans, prohibitive export taxes and import subsidies should be avoided in such situations. Instead the focus should be on eliminating trade barriers,

revitalizing agricultural growth by expanding aid for rural infrastructure, services, research and technology, and ensuring safety nets are in place to shield the most vulnerable.

Policy reforms towards decoupled support to agriculture should be continued, recognizing that good progress has already been made. Further reforms should in particular concentrate on the remaining market access restrictions on agricultural imports, particularly as regards the least developed countries. Backtracking on liberalization would reduce the ability of trade to stabilize markets and generate welfare, with negative consequences for food security. To create stability, and as a matter of equity, developed countries could pledge ODA to agriculture at the level of a given share of the support they provide to their domestic farmers.

Strengthened **regional economic cooperation** should help to provide buffers for local economies in times of economic insecurity and stress. Such arrangements can also enforce capacity to deal with regulation of food safety and commerce

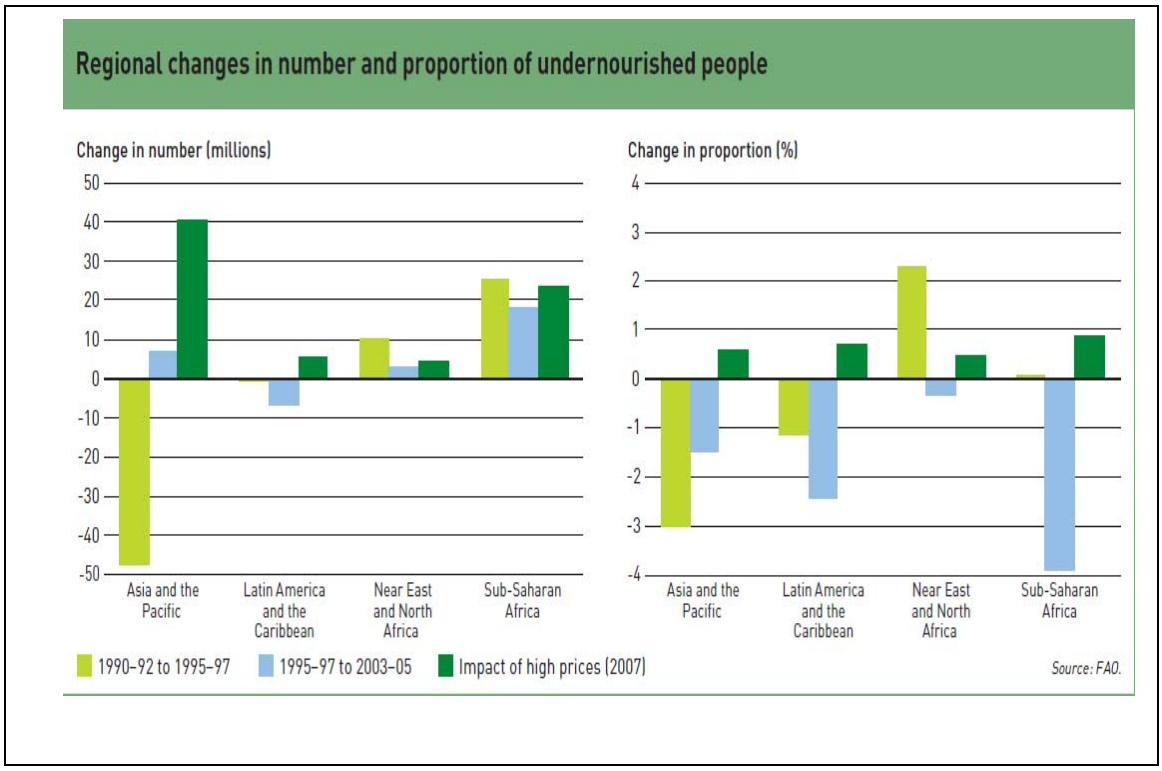
New and innovative arrangements are needed to ensure that levels of worldwide food stocks are adequate and that poor and import dependant countries have access to them, especially at times of extraordinary scarcity.

4. The risks and challenges

The ability of the global food and agricultural system to meet future demand for food, feed and fibre could be severely limited by a number of risks and challenges. The most important risk is that hunger and malnutrition could persist or even continue to rise in spite of food supplies that are sufficient at aggregate levels. Another increasingly worrisome challenge is climate change, affecting developing countries disproportionately. A third challenge that has been emerging with the rise in energy prices is a rapid increase in the use of agricultural feedstock for biofuels, causing additional scarcity on markets for food and feed.

4.1 Hunger amidst adequate overall supplies

During the recent decade global food production has generally followed a positive growth trend, even on a per-caput basis. Nevertheless, the number of chronically undernourished has further grown, not fallen. The extraordinary increase of hunger during the recent food crisis in 2007/2008 occurred in spite of a record cereal harvest in 2008. This is a clear reminder that ensuring an **adequate supply of food at the aggregate level, globally or nationally, does not guarantee that all people have enough to eat and that hunger will be eliminated**. Therefore, it is not enough to confirm that the world can be fed in 2050 and to even ensure that the preconditions for the realization of adequate and sustainable supplies by 2050 will be established. The vital task to be confronted today and in the immediate future is to avoid or at least reduce the risk that the trend of hunger continues to rise. Unless deliberate actions are taken to address that risk, the focus on the longer-term adequacy and sustainability of food supplies could even be misinterpreted as a postponement to 2050 of action to assist the almost one billion people who are undernourished today and to prevent the death of thousands of young children who die everyday from diseases which they would most likely survive under conditions of better nutrition.



Source: FAO (2008)

The reasons why hunger and malnutrition may persist in the midst of adequate aggregate supplies at national or global levels are well known**: lack of income opportunities for the poor and absence of effective social safety nets**. Regarding the first reason, experience of countries that have succeeded in reducing hunger and malnutrition shows that economic growth and poverty reduction policies as such do not automatically ensure success: the source of growth matters too. Overall GDP growth originating in agriculture, in particular the smallholders, is, on average, at least twice as effective in benefiting the poorest half of a country's population as growth generated in non-agricultural sectors. This is not surprising as 75 percent of the poor in developing countries live in rural areas and derive significant parts of their livelihoods from agriculture or activities dependent on it. If and in so far as governments ignore these facts and continue to discriminate against their rural populations in policies and public investments, the risk will remain that under-nourishment continues or even rises even if globally or nationally there is enough production. Needless to add, measures to improve employment opportunities for the other 25 percent of the poor who live in the cities are equally important. Over time, action in urban areas will have to be even extended further.

The second reason why hunger and malnutrition may persist in spite of overall economic growth and adequate aggregate food supplies is the fact that millions of the most deeply poor and hungry are caught in a vicious circle of hunger and poverty. Experience has shown that hunger is often not only the result of poverty, but also its major cause. Poverty deprives people of the means to buy or produce food. On the other hand, hunger and malnutrition cause enormous human suffering. Hungry people cannot work to their full potential and are more susceptible to disease. Malnourished children are unable to learn effectively. Many are handicapped for life. In order to help these people escape from the vicious circle requires targeted and deliberate action in the form of comprehensive social services, including food

assistance, health and sanitation, education and training. A special focus on the most vulnerable, in particular women and children, is warranted.

Responding to the question ‘How to Feed the World in 2050’ must not distract from the even more pressing need to find ways to ensure access to food for the world’s almost one billion hungry today. As a minimum, any policies aiming at resolving the long-term goal should at the same time contribute to reducing the incidence of hunger in the short-term. The basic challenge is thus to give equal priority to short-term and long-term hunger alleviation and to turn agricultural production growth into enlarged access to food.

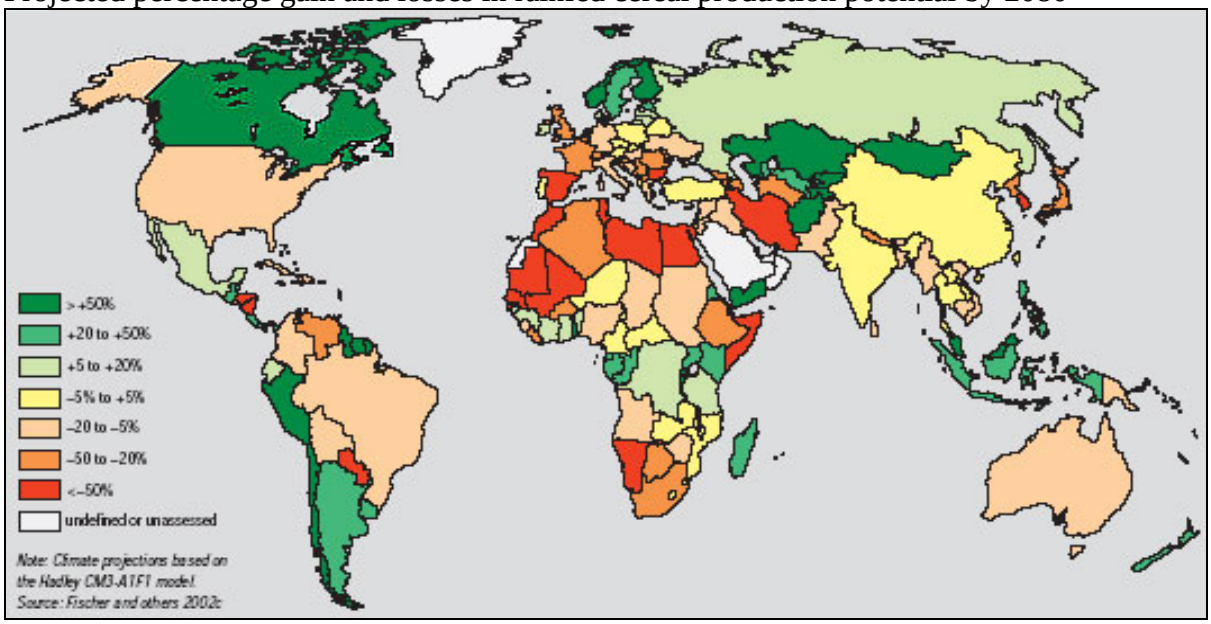
4.2 Climate change

Climate change will **affect agriculture and forestry systems** through higher temperatures, elevated carbon dioxide (CO_2) concentration, precipitation changes, increased weeds, pests and disease pressure. Global mean surface temperature is projected to rise in a range from 1.8°C to 4.0°C by 2100. Such changes will have more or less severe impacts on all components of food security: food production and availability, stability of food supplies, access to food and food utilization.

At the current state of knowledge and in view of the wide consensus among scientists that climate change is already ongoing, climate change is more than a risk. It is a **challenge to take effective action** both to mitigate its effects and to adapt to its unavoidable consequences.

The impacts of climate change on crop production are **geographically very unevenly distributed**. Although the countries in the Southern hemisphere are not the main originators of climate change, they may suffer the greatest share of the damage in the form of declining yields and greater frequency of extreme weather events (droughts and floods). It has been estimated that the aggregate negative impact of climate change on African agricultural output up to the 2080-2100 period could be between 15 and 30 percent. On the positive side, in the temperate latitudes, mostly the Northern hemisphere, higher temperatures may benefit agriculture: the areas potentially suitable for cropping will expand, the length of the growing period will increase, and crop yields may rise.

Projected percentage gain and losses in rainfed cereal production potential by 2080



Source: UNEP (2006)

Recent modelling results suggest that balancing the considerable losses in some regions and the gains in others, the **aggregate effect of climate change on global production** may initially turn out rather small, especially for cereals. However, this will depend on the length of the period considered. While atmospheric changes, and in particular CO_2 fertilization, may initially increase the productivity of current agricultural land, climate change, if not halted, is projected to have a clearly negative impact in the second half of this century. In particular, the effect of increased demand for irrigation water could be enormous.

All current quantitative assessments show that **climate change will adversely affect food security.** On average, food prices are expected to rise due to climate change. IFPRI projects dramatic increases of global maize prices and less dramatic increases of rice and wheat prices up to 2050. In the developing world, the adverse impacts will fall disproportionately on the poor. Sub-Saharan Africa's share in the global number of hungry people could rise from 24 percent to between 40 and 50 percent, depending on model scenarios. The dependence of developing countries on food imports will increase.

Agriculture will have to adapt to climate change, but it can also help to mitigate the effects of climate change. Agriculture currently contributes about 14 percent to Green House Gas emissions (6.8 Gt of CO_2), but also has the potential to mitigate between 5.5 – 6 Gt of CO_2 per year, mainly through soil carbon sequestration and mainly in the developing countries. Additionally, several agriculture-based mitigation options generate significan co-benefit for both food security and climate change adaptation. Useful **synergies exist for adaptation and mitigation in agriculture**. These include conservation agriculture, avoiding deforestation, forest conservation and management, agro-forestry for food or energy, land restoration, recovery of biogas and waste and, in general, a wide set of strategies that promote the conservation of soil and water resources by improving their quality, availability and efficiency of use. Enhancing such possibilities can increase resilience of production systems in the face of increased climatic pressures, while providing carbon sequestration or reducing land-based greenhouse gas emissions. They should form the core of climate policy planning and implementation at national and international levels.

New solutions need to be found in rural areas, in particular in the developing countries, to **enhance mitigation of and adaptation to climate change**. All countries will need to undertake impact assessments and evaluation of policy options for adaptation as well as mitigation, with broad involvement of stakeholders and based on comprehensive assessments of risks and opportunities, benefits and costs. Adaptation to climate change should become an integral part of strategies to enhance disaster preparedness and long-term policies for sustainable development, making maximum use of synergies between adaptation and mitigation in agriculture. Vulnerable low-income countries need special assistance in investing in higher resilience against disaster risk caused by extreme weather events, including droughts and floods. Assistance will be particularly needed in the least developed and most vulnerable countries of Africa. External funding for climate change actions in developing countries should be additional to current ODA.

Particular efforts should be made to include agriculture in the forthcoming **Copenhagen Agreement on climate change.** Developing countries can generate benefits through broader involvement in Carbon markets. Carbon offsets in developed countries should be used to promote carbon reducing but at the same time productivity enhancing agricultural technologies and investments in developing countries.

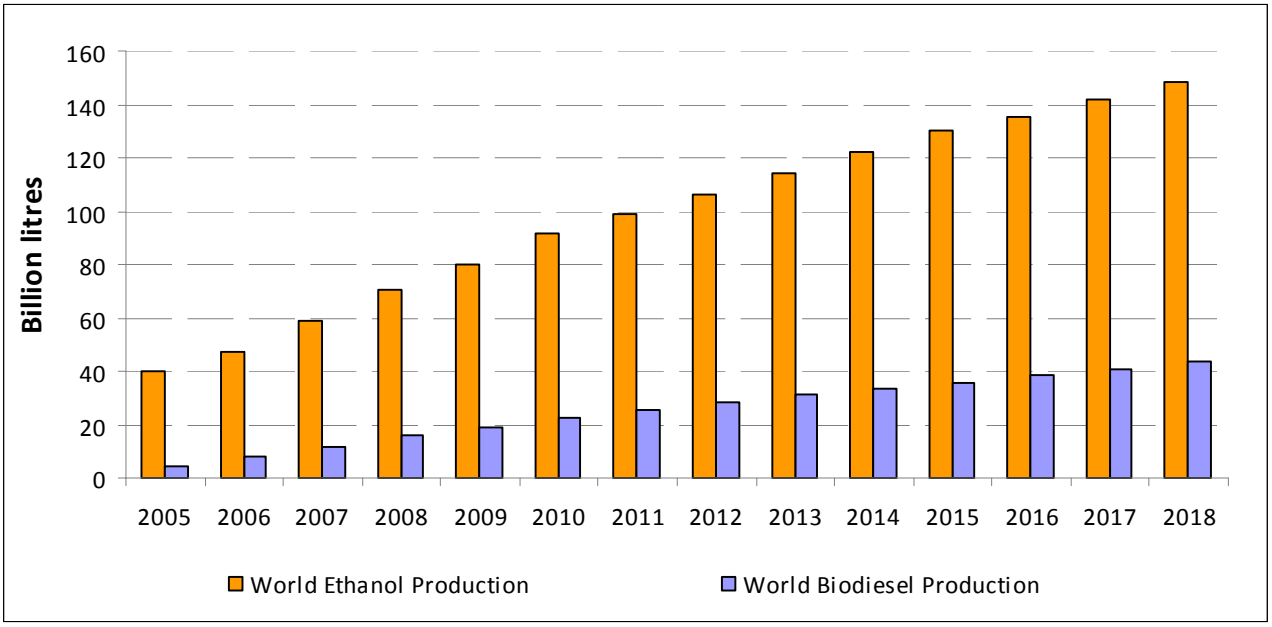
4.3 Biofuels

Biofuel production based on agricultural commodities increased more than threefold from 2000 to 2008 and accounts for nearly two percent of the world's consumption of transport fuels. Various policy measures driving the rush to liquid biofuels, such as mandated blending of biofuels with fossil fuels, as well as tax incentives and import restrictions, have been the main driver of this development. The rapid rise of crude oil prices in the years up to 2008 has created an additional incentive. The drastic increases in prices of key food commodities such as maize, wheat, rice and soybeans in 2007/2008 mirrored the increase in prices of energy products and strengthen the recognition that energy and agricultural markets are becoming more closely linked.

At the currently prevailing ('first generation') conversion technology, a further rise in the use of agricultural feedstock for the production of biofuels would be a **real risk for food security.**

According to OECD-FAO projections, global biofuel production may increase to 192 billion litres in 2018 depending *inter alia* on the future price of crude oils and on support policies in major countries. Accordingly, the demand for agricultural feedstocks (sugar, maize, oilseeds) for liquid biofuels is expected to continue its growth over the next decade and perhaps beyond, putting upward pressure on food prices.

World ethanol and biodiesel projections, 2005-2018



Source: FAO-OECD Outlook (2009)

Despite the limited importance of liquid biofuels in terms of global energy supply, the effects in terms of **reduced availability of food and feed may become significant**, at least at the current state of technology. In 2007/2008 the total usage of coarse grains for the production of ethanol amounted to 110 million tonnes, out of a total utilization of 1120 million tonnes, hence a significant share of roughly 10 percent.

Of particular concern are the possible **adverse effects on the food security** of the poor and the food-insecure if food prices were to rise again as a result of resource diversification towards the production of feedstock crops for biofuels. For example, IFPRI has presented model simulations that project that continuing along the trend suggested in current policies and plans of future expansion in various key biofuel-producing regions, prices of grains, oils and cassava would be at least 4 percent higher by 2015 compared to a reference scenario of keeping biofuel production constant at 2007 levels. As a result, per caput calorie availability would be 3 percent lower in the developing countries. The number of malnourished children would increase significantly. IFPRI estimates that under a scenario of drastic biofuel expansion up to 2050, the number of malnourished pre-school children could be 3 million higher in sub-Saharan Africa and 1.7 million higher in South Asia than would otherwise be the case.

The same study also estimated that investment in research for **productivity growth could significantly reduce the negative effect of biofuel production on food availability**. An added benefit would be the reduced encroachment on forest land and better maintenance of ecosystems. By 2050, a scenario of high investment in agricultural knowledge, science and technology, combined with a medium expansion of biofuel production, would result in an increased calorie availability per person of 30 percent in sub-Saharan Africa and 20 percent in the other developing regions.

Trade impediments notwithstanding, newly rising energy prices could be an **incentive for countries with adequate infrastructure and abundant land and climate resources** that are

suitable for the feedstock crops to invest in the dynamic biofuels industry and take part in this rapidly growing sector. Such opportunities exist, for example, in countries of Latin America, South-East Asia and sub-Saharan Africa. In Africa they include some of the most needy and food-insecure countries. If developing countries can reap the benefits of biofuel production and if those benefits reach the poor, higher demand for biofuels could contribute to rural development.

A **comprehensive assessment** of the costs and benefits of further support for biofuels should include the likely net effects on the intended reduction of greenhouse gas emissions. New research suggests that for some crops and technologies of production and conversion the reduction may not be significant in so far as the price increases resulting from the additional conversion of agricultural biomass may be an incentive for carbon-releasing conversion of additional grassland or forests into arable land and thus defeat the original objectives.

Policies promoting the use of food-based feedstocks for biofuels production should be reconsidered in order to **reduce the competition between food and fuels for scarce resources**. As it is recognized that non-food biomass feedstocks for biofuels will still compete with food and other types of land use for limited resources, more efforts should be made to develop forms of renewable energy that do not depend on food-biomass and, broadly speaking, to promote the efficiency of energy use at household and industry levels.

Where resources and production potential for non-food biomass are available in developing countries, appropriate infrastructure investments should be considered to **help poor farmers take advantage of the opportunities** presented by increased demand and prices for agricultural feedstock for biofuels.

Legislation and monitoring to **limit irresponsible conversion of forests and grassland into arable land** should be reinforced. Moreover, higher investment in yield-enhancing research would reduce the pressure on prices and land and limit the negative consequences on food security.

5. Mobilizing political will and building institutions

At the World Food Summit (WFS) in 1996 the Heads of State and Government stated:
'We pledge our political will and our common and national commitment to achieving food security for all and to an ongoing effort to eradicate hunger in all countries, with an immediate view to reducing the number of undernourished people to half their present level no later than 2015.'

In the meantime, various countries have indeed demonstrated such **political will** by taking successful action to reduce the prevalence of hunger and malnutrition. However, the stagnating or even rising global number of hungry and malnourished people is evidence that other countries either did not succeed although efforts were made or did not even seek to take action. It is certainly true that some of the least developed countries face particular resource constraints, accentuated further by the fact that this group of countries receives the lowest (and declining) amounts of ODA to agriculture per person working in agriculture. However, in many of the low-income countries with high prevalence of hunger, continuing low budget shares for the rural sectors and absence of deliberate institutional reforms reveal that many of

them do not appear to have adequate political will to accelerate progress in hunger reduction. Mobilizing political will to fight hunger must therefore have high priority if the vision of a world without hunger by 2050 is to become reality.

Political will may be mobilized in various ways. One is through international calls for action and pledges. There can be no doubt that the series of Summits of the 1990s and early 2000s, including FAO, the UN and the G8, raised awareness and created commitment at highest levels. As the world seeks to strengthen and accelerate the necessary action, the substance of the action plans, in particular the plan adopted at the WFS need to be recalled.

Following the Summits and international pledges of recent decades, a new and additional momentum could now be sought through **dialogues on food security** at the level of individual countries. Two types of dialogue could be envisaged; one at intra-national level involving governments and domestic stakeholders, and another involving the governments concerned together with their international development partners.

The aim could in both cases be to clarify the significant **political, social and economic gains to be obtained from reduction of hunger and malnutrition.** The aim would also be to draw the attention of governments to their obligations under the UN Charter to respect, protect and fulfil human rights, including the right to food. The right to food concept can add value to effective food security strategy by ensuring transparent policy processes, legal frameworks, accountability of public institutions and clarification of government obligations and of rights and obligations of rights-holders.

At national level, **good governance** extends to providing essential public goods, including political stability, rule of law, respect for human rights, control of corruption and government effectiveness, which are all essential for food security. It has been shown that the absence of good governance can be a major obstacle to hunger reduction, although it is also true that achieving progress depends on many other factors as well. Decentralization and local governance, in particular community-driven development, contribute to effective governance. Moreover, realizing the right to food as part of a concept of good governance provides for practical principles such as broad participation in the policy process, non-discrimination and transparency of the policy process, all of which are important for food security, including social safety nets as well.

Good governance also has an international dimension. The fact that one billion people are chronically undernourished and many more suffer from various forms of malnutrition signals a failure of global governance in the food and agriculture domain. It is therefore extremely important that recent high level commitments to improve global governance of food security, for example, those by the G8 Summit in 2009, be followed up and implemented. This includes in particular the ongoing reform process of the Committee on World Food Security as one of the major instruments of global governance.

Effective institutions are a particular feature of good governance. They are essential to ensure that agriculture and rural areas can serve sustainable development and contribute to food security for all. Priority will need to be given to institutional reforms that ensure that all members of society, rural and urban, men and women, producers and consumers throughout the food chain, including the vulnerable and food insecure, are adequately organized and represented in the policy process. In many countries, rural people, in particular farmers and

farm workers and their families, are currently not able to play an effective role in the political process, nor do they receive the support and incentives they need at all stages in the value chain.

The world has the resources and technology to **eradicate hunger.** It needs to mobilize political will and build the necessary institutions to ensure that key decisions on investment levels and allocation as well as on agricultural and food security policies are taken with the goal of hunger eradication in mind. The expert analysis presented here paints a cautiously optimistic picture of the future of food security in the world.