Increasing productivity is the key

A **second** Green Revoluti

The earth is actually capable of feeding nine billion people. But to achieve this, we will need to raise agricultural efficiency to a new, higher level – by implementing sustainable, innovative solutions.

on

Progress in productivity is needed to secure the supply of food for a growing world population. More and more farmers are becoming aware of this need.

Research and innovation are key elements in the effort to meet the challenges of the future.

The 12th of September last year saw the passing away of Norman Borlaug, the father of the first "Green Revolution". The famous American scientist was awarded the Nobel Peace Prize in 1970, in recognition of his outstanding contribution to securing the global food supply. Through his work, he played an important part in the successful breeding of high-yielding wheat and maize plants. These new, high-performance varieties brought about a rapid surge in food production during the nineteen-sixties and -seventies, thus saving millions of people from starvation, particularly in the developing countries of Asia and Latin America. Today, mankind has to meet an equally daunting challenge: agricultural productivity must be raised up yet another notch – to an even higher level of efficiency.

Rice is an important staple food for many millions of people. Our picture shows Indonesian farmers transplanting rice into their fields.

Mega-cities draw more and more people into their orbits. The need to supply these large population groups with high-quality food opens up opportunities for agriculture.

Before the arrival of the first Green Revolution, around a billion people were suffering from hunger and undernourishment. After a short-lived minor improvement to the situation at the beginning of the nineteen-nineties, this number has, sadly, regained its relevance once again. According to figures from the Food and Agriculture Organisation of the United Nations (FAO), the number of hungry people in the world rose by 105 million in 2009 alone, to reach a total of 1.02 billion. But this certainly doesn't mean that the Green Revolution was a failure, particularly if you consider that the world population has more than doubled since 1960, rising from around 3 billion people then to today's 6.8 billion. In fact, over the last fifty years, agriculture has succeeded in producing enough food to nourish an additional three billion people and more. The foundation for this achievement was a remarkable increase in productivity.

Here's an example from Germany: at the beginning of the nineteen-fifties, about 3.8 hectares of land were needed to produce ten tonnes of wheat. Nowadays, the same amount is being harvested from an average of 1.3 hectares: in other words, land-use efficiency has almost trebled. Although the overall efficiency gain, taken on a global scale, has been smaller, it is still impressive: in 1960, a hectare yielded enough food for 2.4 people on average; in 2005, the corresponding figure was 4.1 people.

More recently though, the productivity gains have been less pronounced – and this is a serious problem. A prognosis by the United Nations suggests that – assuming moderate birth rates – the world's population will have increased to eight billion people by 2025, and even to as many as 9.1 billion by 2050. So on top of solving the current problem of hunger, there will be almost three billion people to feed in addition. Only after 2050 is the global population expected to start shrinking again, as a consequence of the increasing average age. Professor Matin Qaim of the Institute of International Food Economics and Rural Development at the University of Göttingen stresses that agricultural production will have to double by 2050 if all of these people are to obtain the food they need. Demand for wheat is likely to increase by half again (to around three billion tonnes a year); and that for meat by about 200 million tonnes (to 470 million tonnes). If food production is to keep up with population growth, cereal yields will have to increase by 3.3 percent each year for the next 20 years: the present rate of increase lies at only around two percent. "Agriculture simply has to become more productive if it is to feed a substantially bigger population and at the same time, rise to the significant environmental challenges it faces", warned FAO Secretary-General Jacques Diouf at an Expert Forum in Rome in mid-October 2009. The FAO is pushing for substantial increases in public investment into agricultural research, as well as for a broad acceptance of new technologies, agricultural systems and crops. In other words – within the next forty years, we will need a second Green Revolution.

Innovation breakthroughs aren't urgent simply because of the anticipated drop in the available agricultural area per head of population. There are three further mega-trends in global agricultural market structures that will be just as influential:

1. the increasing need for biomass as a renewable alternative to finite fossil fuel reserves, not only to produce energy, but also to produce basic materials;
2. the increasing demand for animal-derived protein that goes along with rising incomes, and

3. climate change – both as a threat to future harvests in today's fertile agricultural regions, and as an imperative to reduce emissions of greenhouse gases.

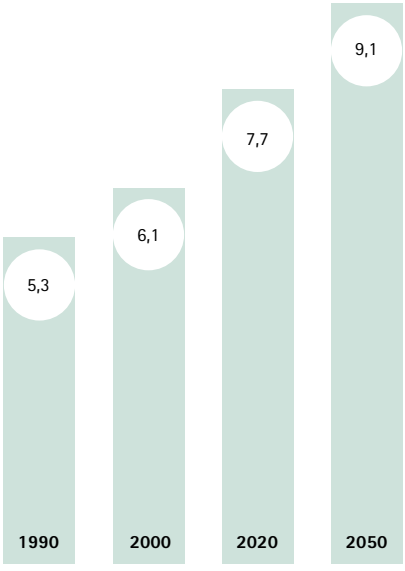
All of this means that there can be no future if we continue to rely on yesterday's methods and practices. As the Chairman of the Board of Management of Bayer CropScience, Prof. Friedrich Berschauer, emphasizes: "If we are to meet the challenges facing food production and use our resources to make cultivation as efficient as possible – against the background of a steadily-increasing world population – then we will need intensive agricultural research." This research must find ways of improving resource management such that significantly higher yields can be obtained in future from the same area of cultivated land.

The use of crop protection agents and fertilizers must become more efficient. Even today's highly-effective crop protection agents are only able to elevate the yields of cereals, rice, maize, potato, soybean, cotton and coffee to 72 percent of the theoretical maximum: crops still suffer from losses to pests, weeds and diseases. If we were to succeed in closing this yield gap, then considerably more food could be produced without having to extend the area under cropping. Only by achieving this we will relieve the threat to virgin forest, nature reserves and wild biotopes posed by the expansion of agricultural land. It follows then that intensification – if it can be achieved without damaging the environment – can also bring ecological advantages.

Researching to increase efficiency

If, in contrast, agricultural technologies were to stagnate at today's current standards, then further virgin natural biotopes would certainly have to fall under the plough. If local populations cannot obtain enough food, their efforts to produce it will not stop at the borders of today's nature protection areas. The FAO predicts that 90 percent of the global increase in food production required

Rising world population



Today, the earth's population exceeds 6.8 billion people. By 2050, there will be more than nine billion people on earth. It will be a major challenge to ensure that enough food is available to meet the needs of a continuously growing population.

by 2050 will have to be achieved through higher yields and more intensive production, and only the remaining ten percent of it through an extension of the agricultural area.

Another fact: food commodities will only be traded at prices affordable to low-income groups if they are produced in sufficient amounts. The extraordinarily high prices for commodities (cereals, maize and soybean, but also milk and milk products) seen recently – mainly in 2008 – have shown the sort of extremes of variability that even minor shortages of agricultural commodities can cause in global markets. And it's poor people in the world's least developed countries who suffer most from these fluctuations.

Efficient water use

Using our precious water supplies more efficiently will also be a priority. This applies particularly to irrigated crops grown in tropical and subtropical regions. Water is already the limiting factor for food production in many regions of the world. There has been an increasing tendency over the last two years for countries that are relatively poorly equipped with agricultural land in relation to their populations (examples include Saudi-Arabia, Qatar and Kuwait, but also China) to buy-up the rights to millions of hectares of productive land in the more extensively agricultural countries of Africa. In doing so, and in claiming the food produced on this land, they are importing a considerable amount of the locally-available water. This requisitioning of land, which has been described as a new form of colonialism by non-governmental organizations, indicates how serious the governments of net-importing countries already judge the situation to be.

High-quality seed of varieties with improved characteristics is likely to play an important role in securing the future supply of food. Broad-scale implementation of innovative technologies, such as hybrid breeding and plant biotechnology, would go a long way towards increasing and securing the harvests of our most important crops. For example, varieties of crop plants whose resistance to drought or extreme temperatures has been strengthened – through gene technology or by other means – could contribute to securing the harvest in the face of climate change. Researchers in the Australian state of Victoria have run successful field trials of genetically-manipulated wheat lines that are capable of delivering stable yields under conditions of water stress. In the 2006/07 season, drought in Victoria destroyed an estimated 70 percent of the wheat harvest. Climate scientists predict average temperature increases for the Australian continent of between one and six degrees Celsius by 2070, accompanied by reduced precipitation. The German Association of Biotechnology Industries (DIB) expects the first drought-tolerant wheat variety to be brought onto the

Bayer CropScience expert Geoff Newman (right) and Rafaele Tassone, a farmer from Mildura in southern Australia, consider uprooted orange trees. Year-long drought meant that Tassone was no longer able to irrigate his plantation, and was thus forced to fell it.

market in five to ten years. For maize, this could happen in two to five years. Authorities in the USA have already received a registration application for drought-tolerant maize.

Plant biotechnology is also likely to contribute to a resource-efficient increase in the productivity of food from animal husbandry. In future, ruminants might be fed more easily-digestible grasses with modified fructan and lignin contents. This would reduce the amount of climate-damaging digestive gases they produce, and at the same time, increase energy yield. Even by 2020, the world's population is expected to be consuming 120 million tonnes more milk than it did ten years ago. It will therefore be essential to increase the efficiency of milk production if methane emissions by the world's milking herds are to be reduced, or at least kept under control. A cow capable of producing ten litres of milk a day emits about 40 grammes of methane for every litre. If productivity is raised to 30 litres of milk a day, then the emission rate sinks to 15 grammes per litre, because the proportion of the cow's total food intake expended on basal metabolism decreases, thus improving efficiency. For a four-fold increase in the amount of milk, a cow only needs a 2.8-times greater energy ration in its feed. Increasing income levels in developing countries mean that more and more people expect to be able to consume animal-derived foods, so this type of efficiency gain is essential if the environmental and climatic impacts of animal husbandry are to be kept under control.

Researching for food security: Jeanine Derks samples plant parts in order to analyse their genetic make-up.

The twin pressures of climate change and dwindling fossil energy resources will propel agriculture to the forefront in supplying the world's population with renewable energy and sustainable supplies of raw materials. Forecasts indicate that between 20 and 30 percent of the agricultural surface might be dedicated to producing biomass by 2025. It follows then that this area will either be lost to food production – or at best only available to a limited extent. This means that biomass production also desperately needs innovative approaches if the conflict between the tank and the plate is to be relieved.

Profiting from technical progress

Before any of this can happen, political change is urgently needed if biotechnological innovations are to be put to good use in agricultural practice in Germany and the rest of Europe. Encouraging agricultural research within the framework of state-financed innovation programmes is only half the story: policy must allow the results of research to be put into practice. European law stipulates that strict testing criteria must be met if registrations are to be granted: but agriculture and consumers will only be allowed to profit from technical progress if these criteria are applied in a consistent, scientific way. If Europe continues to block plant biotechnology, we will be denying ourselves one of the most promising tools available for creating a sustainable improvement in the supply of food, energy and raw materials. ◀

Norbert Lehmann

Water use behind selected products

1 cup of coffee	1 kg rice	1 kg beef	cotton T-Shirt	Car
140 l	*3.000-5.000 l*	*15.000 l*	*2.000 l*	*20.000-300.000 l*

In Germany, average drinking water consumption per head of population has been falling since the 1980s. The daily average usage per person now stands at 130 litres. In contrast, consumption of hidden, so-called virtual water continues to increase. What is meant here is the amount of water that is contained in a product – plus the amount used in its production. Take the example of a cup of coffee: the 200 millilitres you find in the cup are joined by the amount used in cultivating the coffee tree and processing the coffee beans – a total of 140 litres for each cup of coffee. Thus virtual water consumption exceeds actual consumption many times over.

Source: UNESCO, Institute for Water Education, 2008