Agriculture Department
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Fertilizer and the future

"There is still a lot of misunderstanding and confusion about mineral fertilizers. The public needs objective, science-based information from all partners involved in nutrient management"

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Fertilizer seems to have a bad name, and in some surprising circles. During a recent visit to my *alma mater*, the University of Wageningen, in the Netherlands, I was amazed to hear several students say that raising crop yields with fertilizers was very dangerous and even immoral, particularly for African soils. It is time to dispel some myths about mineral fertilizers, to appreciate the role they play in feeding the world, and to assess how best they can help agriculture meet the challenges it faces in the decades ahead.

There is a general consensus about the way agriculture is evolving in response to demographic and economic trends. World population will probably peak at some 8,000 million around 2030, when two out of every three people will live in towns and cities. Rising incomes will create a disproportionally higher demand for food, meaning that over the next three decades food production will need to increase by about 60%. Nearly all of the increase in production will have to come from developing countries through intensification of agriculture, i.e. more yield per unit time and per unit area. As urbanization reduces the rural workforce, agriculture will also need to adopt new forms of mechanization and shift to land use intensification, with all of its connotations. Those scenarios point to an increase in use efficiencies of all natural resources, particularly water, and to the need for greater - although not proportionally greater - use of mineral fertilizer.

Yield increases. Half a century ago, farmers applied only 17 million tonnes of mineral fertilizers to their land. Today, they apply eight times as much. In northern Europe, fertilizer use has increased from about 45 kg/ha to 250kg/ha since 1950. In the same period, wheat yields in France increased every year, from about 1.8 tonnes/ha to more than 7 tonnes/ha. The growth

in fertilizer use is lower than the increase in yields, and confirms the overall pattern of increasing efficiency in fertilizer use.

Fertilizer application currently accounts for 43% of the nutrients that global crop production extracts each year, and the contribution may be as high as 84% in the years to come. Contrary to some public opinion, non-mineral nutrient sources are unlikely to challenge mineral fertilizer in the future: while there will be more manure available as livestock production increases, and urbanization produces more waste, especially sewage, their efficiencies are considerably lower and the current cost of using waste for crops is still quite high.

Organic agriculture, which eliminates the use of synthetic inputs, does not appear to be a feasible alternative. At FAO, we have done some very tentative calculations of what organic agriculture would mean on a global scale if market demand for organic produce increased substantially. The consequences are quite staggering: a large amount of land that would have to be brought under rotation with legumes or under animal production to make up for the lack of mineral fertilizer. While organic agriculture does fill a niche market, its limits - and its dangers, in terms of nutrient depletion - need thorough review.

The question is not whether but by how much fertilizer use will need to increase. At the World Food Summit in 1996, governments committed themselves to halving the number of hungry people by the year 2015. There is a direct link between that WFS goal and fertilizer use. Possibly, it means an 8% increase in fertilizer applications compared to the "business-as-usual" scenario. That does not seem very much, but in terms of its tonnage, it is considerable. Enhanced fertilizer use to meet WFS goals is particularly important in countries such as China and India, which make up a large proportion of the world population. But it may be even more important in Africa, where increases of 2.7% or more a year are needed in order to make up for nutrient losses, and in the humid tropics, where unfertilized annual cropping takes a heavy toll of soil organic matter.

Fertilizer use efficiency. Improving the efficiency of fertilizer use is the challenge of the future. One possible direction is improving fertilizer use and plant nutrient uptake efficiency through biotechnology. Hardly any current work in biotechnology addresses abiotic stresses or biological nitrogen fixation. While there may be scope for such research, we should be very careful about promising too much, too quickly. In any case, there is still a lot to gain from conventional plant breeding. For example, considerable work has been done on the so-called "staying green" characteristics of crops such as sorghum - the longer the crop stays green, the more fertilizer uptake there is over time.

Another promising area for research is soil biology. Although it remains an isolated field, we do know that soil organic matter and soil biology are important in nutrient management, and that nutrient recovery for fertilizer is much better with soil improvement. In Africa, where the recovery of nutrients is very low, more systematic work is needed on soil organic matter and on soil quality in physical, biological and chemical terms. Since biological nitrogen fixation produces mixed results, scientists need to link it to the application of more conventional fertilizers and study recovery. Results would probably show that biological nitrogen fixation is not a miracle solution by itself, but is successful under certain conditions.

Integrated management of production systems offer a proven path to greater fertilizer use efficiency. Remarkable results in rationalizing pesticide application have been achieved by making farmers more aware of integrated pest management through field schools, where they learn to observe crops closely and discuss the management of the pests and pathogens. These activities are increasingly linked to integrated nutrient management - farmers are being trained to observe the real impact of nutrient application rather than, for example, applying more and more urea simply because it is the cheapest fertilizer. Farmers also need to understand the effects of over-use of nitrogen on certain pathogens and other stress factors in crops. This may convince them of the need to buy non-nitrogen fertilizer and adopt much more balanced fertilizer applications.

Private/public partnerships. The gains to be made from fertilizer use efficiency, even from a purely economic standpoint, could be significant. However, those gains depend on a broad range of factors that determine fertilizer use and fertilizer application by farmers. We need private/public partnerships, much better systems of distribution and quality control, and the array of marketing tools that goes with it. The fertilizer industry should become more creative in ensuring that the farmer actually obtains the maximum benefit from existing crop and fertilizer application techniques. This means looking systematically at ways of reducing labour demand, which is particularly important as the availability of agricultural labour declines. For example, new polymer-coated fertilizers could offer a much better recovery rate. The industry should also look at the total cycle of nutrient use and nutrient recovery, remembering that the automobile manufacturing industry heard the same plea 20 years ago and has since made considerable progress.

There is still a lot of misunderstanding and confusion about soil nutrients and, in particular, mineral fertilizers. The public needs objective, science-based information from all partners involved in nutrient management. We must, in other words, tell people what we know. We know productivity gains are necessary and possible. We know that more fertilizers are needed. We know that fertilizer use can be far more productive and efficient, if we do it in the right way and in the right context.