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PLANT NUTRIENTS:
WHAT WE KNOW, GUESS AND DO NOT KNOW

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"Plant nutrients:
What we know, guess and do not know"

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Ladies and Gentlemen, Friends and Colleagues,

It is a great pleasure to be allowed to address you here. Many of you know that the subject of fertilizers and nutrients is one that is very close to my heart.

A couple of weeks ago, I was back at my Alma Mater, the University of Wageningen, where I lectured to students from various countries, including Africa, on integrated plant nutrients and food security. I was quite amazed to hear several students tell me that raising yields with fertilizers was actually immoral, something very dangerous, particularly for African soils. That is why I thought that I should call my talk today "What We Know, What We Guess and What We Do Not Know".

The time has come first to dispel some myths about fertilizers and nutrients and to convey a message to a world which is increasingly urbanized and removed from what agricultural production is all about.

So let me take you through a number of steps about "What we know and what we do not know", and how we should deal with communicating this message to the rest of the world.

We know the consensus

About current agriculture and about the way it will in all likelihood evolve: we know that population will grow and will probably peak in about 2030 around 8 billion. We also know that food production will need to increase by about 60 per cent. We also know that nearly all of that increase has to come from developing countries and has to come from the intensification of agriculture, i.e. more yield per unit time and per unit area. In 2030, we will reach a historical moment in the history of human kind, when the era of land expansion, which started some six, perhaps even seven thousand years ago with the beginning of agriculture, will be over forever. If IFA and FAO still exist in 2030, I think we should celebrate this moment.

We also know that demand for food will increase disproportionately to the increase in population. Rising incomes will mean a disproportionately higher demand for food to make up for malnutrition today and to accommodate a shift in diets. Apart from vegetables and fruit, the most remarkable shift will be towards higher consumption of animal products, partly from monogastrics, i.e. from pigs and poultry. This will mean increased production of feed. The cereal market for feed will grow fastest, and it is the only one which will have at least a noticeable impact on world market prices.

We also know that the increase in production will mean an increase in fertilizer use and an increase in use efficiencies of all natural resources, in particular water. Having just participated in the Kyoto World Water Forum, I am particularly aware of the interactions between water availability and fertilizer and nutrient availability.

We also know that urbanization will continue. In 1950, two-thirds of the world population lived in rural areas, in 2030 or even before that, two-thirds of the world population will live in urban areas. This means lower labour availability in rural areas. It will undoubtedly imply new forms of mechanization. Labour use efficiency is another very clear trend. Therefore, land use intensification, in all of its connotations, is one of the things we do not doubt.

It is likely that agriculture will have other dimensions beyond food and fibre production, such as the role of agriculture in carbon sequestration, in preserving landscapes, in preserving watersheds and biodiversity. There are exciting developments in the nutripharmaceutical and food quality sectors that may impact on future agriculture. These other dimensions are less clear, and I would put them more in category of what we guess, rather than what we know. Nevertheless, it is sure that we will look at agriculture as something beyond just producing calories per hectare in 2030.

We also know that higher yields mean higher fertilizer use, but not proportionally. I hope that more efficient fertilizer use will match the growth in production. I say, “I hope” because there are some parts of the world where this hope, particularly in Africa, is not realized today.

What we know: future yields will involve higher fertilizer use

In 1950, farmers applied only 17 million tonnes of mineral fertilizers. That was four times more than in 1900 but eight times less than today. When we look at it in Northern Europe, fertilizer use has increased from about 45 kg/ha to 250kg/ha. Wheat yield in France, for instance, increased every year from about 1800 kg/ha in the 1950's to more than 7000 kg/ha today. Again, we see overall patterns of efficiency in fertilizer use; the increase in fertilizer use certainly is lower than the increase in yields. So far, so good. On the loamy soils of Northern Europe, we now get yields that are over 10 tonnes/ha. This yield is very close to the present biological maximum, and it is obtained with only 200 kg of nitrogen and 50 kg of phosphate and potassium respectively. The potential to improve fertilizer use efficiencies is thus tremendous.

An entire system of supply, of research, of extension, of quality control of inputs, etc., ensures that farmers are realizing these efficiencies. In Asia and other parts of the world, these increases are not very strong but they also exist. There is tremendous scope for improvement in efficiencies as long as we remember what I was told when I was a student “don’t fertilize the soil, fertilize the plant”.

Now, let us look into the future and now I come in the realm of what we guess rather than what we know.

What we guess: the future of fertilizers

We know that fertilizer application contributes 43 per cent of the 70 million tonnes of the nutrients that global crop production extracts. In the future, the contribution may be as high as 84 per cent, i.e. the world's agriculture will become more and more dependent on mineral fertilizer.

Whether crops will remove indeed more than 207 million tonnes in 2015 and even more in 2030, we do not know that exactly. Nevertheless, what we know is that the increase of fertilizer as part of the total nutrient cycle will be important. This has serious consequences for the way we look at the fertilizer industry and the way we manage fertilizer.

The public often thinks that non-mineral nutrient resources are a major source also for the future. However, their efficiencies are considerably lower. There will be more manure available with increased livestock production. Moreover, urbanization means more waste, especially more sewage waste. The current cost of using waste for crops is still quite high. Maybe some of these costs will reduce, but in any case, fertilizer will remain the most important source of added nutrients.

The question is how much fertilizer use will increase. Even a one per cent increase between now and 2030 is a considerable increase. In parts of the world, we need a much larger increase, up to 2.7 per cent and more in Africa annually, in order to make up for nutrient losses. We know still rather little about trace elements and micronutrients in a systematic fashion or in terms of global cycles. This area needs to be looked at with priority if we want balanced nutrient management.

We also know relatively little about the scope for organic agriculture, a subject that is so dear to some sectors of Western society and often such a source of confusion. At FAO, we have done some very tentative calculations about what organic agriculture would mean on a global scale if indeed the market would demand a very substantial increase in organic agriculture. The consequences of that are quite staggering, considering the amount of land that would have to be brought under rotation with legumes or under animal production to make up for a situation where farmers will not use mineral fertilizer. It seems quite unfeasible. In terms of public awareness, we should develop a clear, scientifically based, view of what organic agriculture can mean in terms of world food security. While organic agriculture provides a niche market, the limits of organic agriculture and its danger in terms of nutrient depletion need thorough review. Not just in OECD countries but increasingly also in developing countries, the public needs objective information on the potential of organic agriculture.

We know fertilizers are irreplaceable

We know, particularly in Africa, with its specific soils, that fertilizers are irreplaceable. That is a message that has to be put across to students as well as the general public. Probably one of the most destructive systems, in terms of environmental damage, is unfertilized annual cropping in the humid tropics with its high impact on soil organic matter and on erosion. We need to look at systems in a much more integrated way in time space. In addition, an integrated approach to

nutrient management is really important and should move the discussion away from just talking about fertilizers in the narrow sense of the word.

We know about crop improvements

The basis of the Green Revolution was crop varieties with improved responses to nutrients and water. Since then, while there is considerable interest in biotechnology, not so much yet is heard about biotechnology and fertilizers. We should ask ourselves – and this is really in the category of what we do not know yet – "Is there a possibility of improving fertilizer use and plant nutrient uptake efficiency through biotechnology? Hardly any current work in biotechnology addresses abiotic stresses or biological nitrogen fixation. There may perhaps be scope to do so, but we should not focus too much on biotechnology. There is still a lot to gain with conventional plant breeding. For example, considerable work has been done on the so-called "staying green" characteristics of a crop like sorghum, as the longer the crop stays green, the more fertilizer uptake there can be over time.

So while we should not underrate the longer-term potential of biotechnology, I also feel that we should be very careful in promising too much, too quickly. Possibly, the conventional breeding work on aluminium and iron toxicity has applications also for biotechnology. I put that in the category of what we do not know yet. However, what we do know is that we have made advances in integrated management of production systems. Conservation agriculture, for example, clearly yields results, and clearly allows us to reduce stresses on the environment with respect to run-off and erosion. So again, we should look at the whole production system, rather than just the nutrient part of it.

We guess about other nutrient sources

What we guess about is other nutrient sources. I already said there is a growth in waste material and manure as we go on toward 2030 and I have pointed to the importance of micronutrients and trace elements. However, how much we can do, for example, with P fixation, or with nitrogen fixation in the current state of knowledge is still very unclear. Developed country agriculture uses maybe 20 per cent of all treated sludge. Perhaps it is only 5 per cent in the near future in developing countries. These are not enormous numbers, but it could very well be that increased urbanization puts such stress on waste management that we are forced, because of the environmental health issues, to deal with the waste in a much better way. This would be an impetus again for integrated nutrient management in the world.

There is interesting cereal-legume rotations work that perhaps deserves more systematic application. Such work links with water use efficiencies, dry land agriculture and water harvesting and needs again a comprehensive review.

We also don't know much about soil biology

Soil biology is another area where we know very little and where we should know more. It's still a rather isolated field of research and does not always link very well with nutrient management. We certainly know that soil organic matter and soil biology are important, but we do not have very good tools to monitor that. We also know, of course, that nutrient recovery for fertilizer is much better with soil improvement. However, much is still unclear in practical terms.

It is sure that in Africa, where the recovery of nutrient is so low, more systematical work is needed on soil organic matter and on soil quality in a physical, biological and chemical way. Biological nitrogen fixation yields mixed results. It is clear that we need to look at it again in an integrated manner, linking biological nitrogen fixation to the application of more conventional fertilizers and study recovery. It would be necessary to have clearer evidence on this and again to communicate that to the public, in order to show that biological nitrogen fixation is not a miracle solution by itself, but may be successful under certain conditions.

We know the World Food Summit's implications for fertilizer use

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 the WFS goal and fertilizer use. Possibly, this means about 8 per cent more fertilizer use with respect to a business-as-usual scenario. It does not seem like very much but in terms of its tonnage, it is considerable.
The enhanced fertilizer use for the WFS goals is particularly important in countries like China and India, which make up a large proportion of the world population in terms of meeting those goals. But even more so, perhaps, in Africa, where regretfully little progress is made in most countries with respect to the WFS goals.

We know potential gains are considerable

We can learn, I think, in this respect from the work on pesticides. There have been quite remarkable results in reducing pesticide applications by making farmers more aware of integrated pest management through a system called farmer field schools, where farmers learn to observe their crops closely and discuss the management of the pests or the pathogens and their predators. Those projects are increasingly linked to integrated nutrient management and this is a very promising approach. It would require farmers to observe better the impact of nutrient application rather than letting them apply more urea just because it's the cheapest fertilizer and thus creating a risk of over application of urea.

We also need to see how we can help farmers to understand the effects of over use of nitrogen on certain pathogens and other stress factors in crops. This may convince farmers of the need to free up money to buy non-nitrogen fertilizer and adopt a much more balanced fertilizer application. In addition, farmers will need help with investing in better water use, water management and water capture. We are talking about a comprehensive package. The real risk is to think that fertilizer is the one and only solution to productivity increase. We really stand to gain from such integrated agro-ecological management. History shows us that the gains of nutrient use are tremendous. Yes, there is a curve of diminishing returns that we need to manage very carefully. An increase of end-use efficiency, even from 40 to 50 per cent, could make considerable savings for farmers, as well as in the transport industry, and in the way poor countries use scarce foreign currency on fertilizers.

The gains of fertilizer use efficiency, even purely economically, may be tremendous. However, we will not have these gains if we do not work on the entire set of factors that determine fertilizer use and fertilizer application by farmers. We need private/public partnerships. We need a much better system of distribution and quality control, and the array of marketing that goes with it.

The industry should become more creative in ensuring that a farmer actually gets the maximum benefit out of the existing crop and fertilizer application techniques. Let's systematically look

at key ways to reduce labour demands, which is particularly important with decreasing labour availability, using all kinds of possibilities. For example, there are now polymer-coated fertilizers that could have a much better recovery rate. I know they are expensive, but let us not forget that the first computers and the first colour televisions were also incredibly expensive, and have now reached many households in the poorer world. Fertilizer use efficiency is the challenge of the future. I really hope that the industry will also look at the total cycle of nutrient use and nutrient recovery. Let us not forget that the car manufacturing industry received the same plea 20 years ago and has made considerable progress.

Governments, industry, NGOs, farmers and international organizations and FAO must make sure we develop a balanced objective and science-based, evidence-based message about fertilizers, about its potential but also about its limitations and about the need to look at fertilizers in a total context. I am looking forward to hearing from you how you would like to tackle this, both at the national and at the international level.

We know that there is still a lot of misunderstanding and confusion about nutrients in the world. The public needs to obtain an objective image and an objective message from all the partners involved in nutrient management. We must, in other words, tell what we know. We know about productivity gains. We know that more fertilizers are needed. We know that fertilizer use efficiencies are possible, if we do it in the right way and in the right context.

Thank you very much.