

International Fertilizer Industry Association

*A message from the  
International Fertilizer Industry Association (IFA)  
to the FAO World Food Summit, November 1996*

## **Plant Nutrients for Food Security**

*“The major challenge is to promote a balanced and efficient use of plant nutrients from both organic and inorganic sources at farm and community levels to intensify agriculture in a sustainable manner.”*

*IFPRI, A 2020 VISION FOR FOOD, AGRICULTURE AND THE ENVIRONMENT, 1995*



*The International Fertilizer Industry Association (IFA) is a non-profit industrial association representing around 500 members in over 80 countries. IFA actively promotes efficient, responsible production and use of plant nutrients to maintain and increase agricultural production worldwide.*





**Video address by Jacques Diouf, FAO\* Director General, to the IFA Annual Conference, Berlin, 1996**

“... Stocks of cereals are at their lowest in 20 years and there are great concerns expressed as to the availability of stocks to meet the demand for the months to come. It is therefore important for the fertilizer industry to deal with a very important factor for the increased production. We have naturally to look at the situation where developed countries are using high levels of input and developing countries are still at a very low level of access and availability of this important factor for the increased production.

Fertilizers have to be used in a sustainable way and with a proper combination of mineral and organic fertilizers in the framework of an integrated plant nutrition approach, taking into consideration the situation of the soil, water and overall environment. We are therefore convinced that your discussions will be very useful in exploring ways and means by which the different fertilizers you are producing in different parts of the world will be properly used to enhance and secure production to improve productivity, yet in a way that would not harm the environment and that would allow the world to continue to provide one of the most basic needs of the human being, which is the need for food.”



‘For those of us on the food production front, let us all remember that world peace will not be built on empty stomachs and human misery. Deny the small-scale, resource-poor farmers of the developing world access to modern factors of production - such as improved varieties, fertilizers and crop protection chemicals - and the world will be doomed - not from poisoning, as some say, but from starvation and social and political chaos.’

*N.E. BORLAUG AND C.R. DOWSWELL, 1994*

\* FAO – Food and Agriculture Organization of the United Nations

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# Plant Nutrients for Food Security

'By the year 2025, 83 percent of the expected global population of 8.5 billion will be living in developing countries. Yet the capacity of available resources and technologies to satisfy the demands of this growing population for food and other agricultural commodities remains uncertain. Agriculture has to meet this challenge, mainly by increasing production on land already in use and by avoiding further encroachment on land that is only marginally suitable for cultivation.'

AGENDA 21, CHAPTER 14, PARA 1

## Introduction

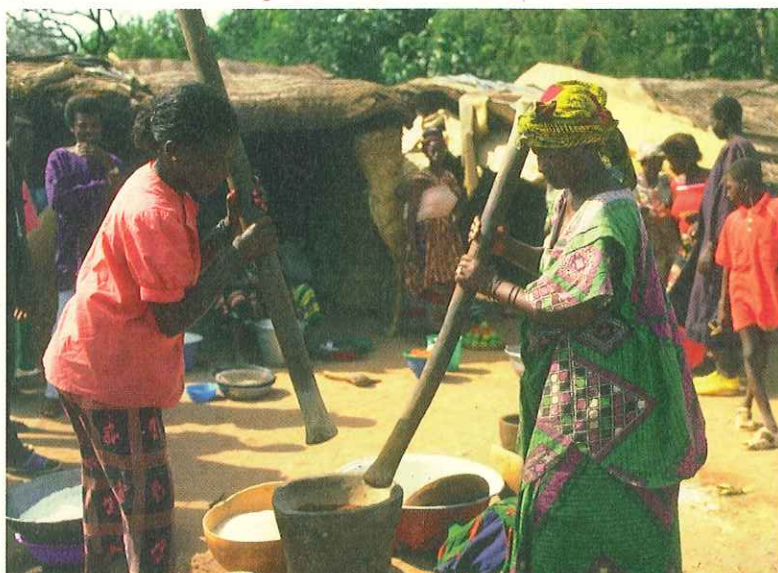
The world population has doubled over the last 40 years - from 3 billion in 1960 to an estimated 6 billion in the year 2000 - increasing at a rate of 90 million people per year to a predicted 8.5 billion people by 2025. Most of this growth will occur in developing countries, a great number of which are already experiencing food deficits. World food supplies will also have to increase substantially to alleviate current malnutrition and to provide adequate food for the expected population, particularly in rapidly expanding urban areas.

While the challenge is generally recognized, there seems to be little agreement on the ways of generating the supplies required to meet demands of such magnitude (18). Plants, grown as crops, are the major source of food both for direct human consumption and as feed for animal production. The major objective in the 1960s was to foster increased crop production. Attention has since been concentrated on other issues such as the 'energy crisis',

conservation of the environment, sustainable management of natural resources, rehabilitation of marginal lands, production surpluses in rich countries, and the liberalization of trade.

With regard to developing countries, the FAO study *'World Agriculture: Towards 2010'* (9) indicates that two thirds of the expected increase in crop production will have to be derived from yield increases on land presently under cultivation. With a finite cultivable area, these increased supplies can be obtained only through higher production per unit of land, through a stimulation of crop growth by improved farming practices.

With regard to the intensification of agriculture, the application of fertilizers, the use of organic sources of plant nutrients, the levels of inputs required and the effects of plant nutrition on the environment, have been the subject of controversies and misleading information. It is the purpose of this paper to clarify these issues and to promote the effective management of plant nutrition, which is a major component in sustainable agricultural production and food security.



## Is agriculture sustainable?

With a rapidly growing world population the question arises whether the ecological balance and the production capacity of the resource base can be maintained without creating a conflict between people and nature. Despite the considerable increases in food production over the last three decades there is a growing concern in the global community that these gains cannot be sustained.

Research and improved farm practices have shown that agricultural development and environmental protection can be reconciled. However, the development of appropriate formulas depends not only on the design of improved management techniques but primarily on the status of agriculture and of farmers in our society (11). How can poor and hungry people be expected to protect natural resources and the environment and concern themselves with the well-being of future generations when their immediate survival is at stake? If the first priority is to feed the world's population, the importance of this issue should be reflected in the distribution of a nation's resources, in farmers' incomes and the priority given to national agricultural policies. Technical measures to prevent different forms of land degradation have often failed because they addressed symptoms rather than underlying the causes - poverty and social inequality.



'Mineral fertilizers play a vital role in intensive agriculture, and their use is not inconsistent with sustainable agriculture and rural development. Few cultivated soils are perfectly balanced. Fertilizer and soil additives, from both mineral and organic sources, must be applied periodically to maintain or build up productive capacity.'

*NEW DIRECTIONS FOR AGRICULTURE, FORESTRY AND FISHERIES, FAO 1994*

### The Role of Fertilizers

The use of commercial inputs, such as fertilizers, has generated questions about the sustainability of intensive agriculture. It should be stressed that problems of sustainability differ markedly between developed and developing countries. In developed countries they may arise from overuse of agricultural inputs, improper tillage or continuous mono-cropping. In developing countries, they are usually related to a lack of agricultural inputs, the low productivity of manual labour and the reduced fallow in shifting cultivation as a result of population pressure. In developing countries environmental damage is often due to low-intensity agricultural practices which require horizontal expansion of cultivation onto marginal areas prone to degradation. Sustainable development in such countries should therefore be sought within an overall framework of growth towards a more effective, stable and productive agriculture.

### Nutrient Cycles

A common interpretation of the concept of sustainability in the context of plant nutrition is that farmers should be able to operate within a closed cycle. Nutrients extracted from the soil are passed through the food chain and then returned to the soil allegedly without a need for external inputs. However, losses inevitably occur through leaching and volatilization. Since recycling does not provide for any added external nutrient supply, yields remain low, farming stays at a subsistence level and leads to a perpetuation of poverty. The same applies to shifting cultivation when nutrient removal is no longer remedied by long fallows as a result of population pressure and land shortage. When nutrients are exported from the farm they need to be replaced and plant nutrition

has to be consciously managed. Like any system that produces outputs, agriculture also requires inputs to be sustainable.



## Do crops need to be fed?

Plants, like all organisms, need nutrients to live and to grow. Plants are supplied with nutrients mainly from soil reserves, soil organic matter, organic residues, mineral fertilizers, biological nitrogen fixation, aerial deposition, irrigation, flood or groundwater, or a combination of several sources.

Three '*primary nutrients*' - nitrogen (N), phosphorus (P) and potassium (K) are consumed in relatively large amounts. Three '*secondary nutrients*' are taken up in smaller quantities: calcium (Ca), magnesium (Mg) and sulphur (S). Very small quantities of '*micro-nutrients*' or '*trace elements*' are often important for plant or animal metabolism, such as iron (Fe), zinc (Zn), manganese (Mn), boron (B), copper (Cu), molybdenum (Mo) and chlorine (Cl). Some other elements may be required for specific crops such as sodium (Na) and cobalt (Co).

### The advantage of mineral fertilizers

The nutrient reserves available in soils differ widely in relation to their composition. Their release is slow and is generally insufficient to compensate for the removal of nutrients by agricultural production, even more so in the tropics where soils are strongly depleted through weathering. The use of mineral fertilizers is a relatively recent development in the history of agriculture. Mineral fertilizers are industrially processed concentrates of plant nutrients which come in a form which is convenient for transport, storage and application. Their known, guaranteed nutrient content makes precision application possible and the relatively high concentration of nutrients reduces very substantially the costs of transport and storage.

The more commonly used organic sources of plant nutrients are manure, slurry, compost and sewage sludge. Mineral fertilizers have a higher content of active ingredients - 20 to 50 percent - and a lower bulk.

### Other nutrient sources

Biological nitrogen fixation occurs through the medium of bacteria which convert nitrogen from the air in symbiosis with leguminous crops, shrubs or trees, or with azolla in wetland conditions. Certain nutrients may be supplied through aerial deposition, for instance nitrogen or ammonia in solution in rainwater, sulphur through precipitation and calcium in the form of dust. Plant nutrients may also be derived from irrigation water, floodwater or groundwater. The nutrient content of water varies widely depending on its composition and the nature of its sediment load.

A balanced and effective use of the different sources of plant nutrients is the objective of *Integrated Plant Nutrition*.

'By 2010, a substantial increase in cereal and tuber yields is required in sub-Saharan Africa in order to improve the availability of food for the increasing population. Currently the crop yields achieved are well below those that could be possible. In order to achieve those levels, however, the average available annual growth rate of the bulk of plant nutrients within the biomass of food crops should be close to 3.5 per cent. For the time being, the growth of the quantity of plant nutrients involved in the cropping systems is based on the 'mining' of soil reserves and the plant nutrients stored in natural vegetation.

The present contribution of mineral fertilizer to the supply of plant nutrients to the crops is extremely limited (less than 14kg of nutrients/ha of arable land for all countries). While organic sources of nutrients will play an essential role, nutrient depletion of soils in sub-Saharan Africa requires an increase in consumption of mineral fertilizers as a prerequisite for the increase of crop production to partially satisfy the forecasted requirements.'

THE UNITED NATIONS SYSTEMWIDE SPECIAL INITIATIVE ON AFRICA, 1996



'In sub-Saharan Africa, nutrient output from all sources currently exceeds inputs by a factor of three or four, the net loss being estimated at some 10 million metric tonnes per year. As a result, more marginal lands and fragile natural ecosystems are put under agricultural use, thus creating further land degradation and other environmental problems. The integrated plant nutrition approach aims at ensuring a sustainable supply of plant nutrients to increase future yields without harming the environment and soil productivity.'

AGENDA 21, CHAPTER 14, PARA 83

## What is Integrated Plant Nutrition?

Suitable application of mineral fertilizer is an efficient and reliable way of boosting crop production, but their cost and other constraints frequently deter farmers from using them. Hence a combination of mineral fertilizers with locally-available organic sources of plant nutrients is recommended. Such mixed applications are also complementary because organic material benefits the soil beyond its nutrient content, including improved soil physical conditions, improved water retention, enhanced nutrient retention capacity and biological activity.

*Integrated Plant Nutrition* is an approach which adapts plant nutrition to a specific farming system and particular yield targets, the physical resource base, locally available and accessible nutrient sources of both organic and mineral origin (6) and the socio-economic background. *Integrated Plant Nutrition* aims to ensure sustainable agricultural and rural development with special attention to developing environmentally sound and economically beneficial plant nutrition technologies.

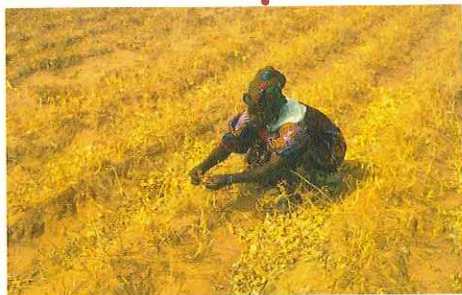
### The role of organic inputs

Organic sources of plant nutrients can be derived from the recycling of residues, from a transfer from non-cropped areas to arable land, from biological N fixation through leguminous crops or green manures, or through nitrogen fixing trees. While the use of these sources should be actively promoted it must be realized that they are by themselves not sufficient to sustain soil fertility. Recycling crop residues reduces losses but does not compensate for the nutrients exported in harvests, nor does it add to the total amount of nutrients originally available. With regard to transfer from non-cropped areas, considering the low content of nutrients in manure, or in collected fresh organic matter, the area providing nutrients needs to be relatively large and is seldom available to small farmers. Green manures are difficult to maintain in communal land tenure systems and the low frequency of leguminous crops in farm rotations limits the annual average supply of fixed nitrogen. The introduction of nitrogen-fixing trees - alley-cropping - appears to require additional validation prior to its further extension (4). Furthermore, nitrogen fixation requires an adequate phosphorus status in soils which is frequently lacking in the tropics.

### Limitations

The adoption of *Integrated Plant Nutrition* by farmers will depend on its capacity to generate tangible yield increases ensuring a return for costs and labour. Considering the great diversity in availability and composition of organic inputs and the complexity of their mineralization processes, applications according to site specific conditions are required.

It is now widely acknowledged that, while the use of locally available organic materials is to be actively promoted, the use of only organic sources of plant nutrients will not ensure the required production increases. On the basis of 'traditional agriculture' the planet could feed no more than 2.6 billion people - less than half its present population (3). *Integrated plant nutrition* systems must include a part for mineral fertilizers in order to meet production targets, in addition to sustaining and enhancing soil fertility.



## What is soil fertility?

Soil fertility refers to the capacity of a soil to supply adequate and sufficient nutrients to plants. This definition is often narrowly interpreted as a 'chemical' one pertaining to the amounts of nutrients which a soil contains. The concept is, however, much broader. It encompasses also the physical characteristics of soil, water holding capacity, bulk density, rooting depth, structure and porosity, which all directly influence the uptake of nutrients by plants. Biological properties are equally important for enhancing the availability of nutrients and for the mineralization of organic matter. Furthermore, it is not only the 'inherent fertility' of a soil that is important, but also its responsiveness to inputs. The maintenance, enhancement and rehabilitation of soil fertility are important for the promotion of food security.

'What is the proper level of inputs for sustainable agriculture?

Integrated plant nutrition systems (IPNS) combine organic material and mineral fertilizers to replenish the plant nutrients removed by the crops and enhance soil fertility. While maximum use should be made of local resources, such as crop residues, green manure and biological nitrogen fixation, residual organic matter does not replace the harvest that is removed, and large areas of acid soil in the tropics produce organic matter which is low in plant nutrients. IPNS can be tailored to the resources available in different agro-ecological conditions and farming systems.'

*FAO, NEW DIRECTIONS FOR AGRICULTURE, FORESTRY AND FISHERIES 1994*

### The processes involved

When farmers apply nutrients, either in organic or mineral form, it is in the first instance the soil that is being fertilized, not the plant. It is only indirectly, through the soil, that crops benefit from the inputs that are being supplied. The soil functions as a conversion system that receives, stores, transforms, transports and exchanges plant nutrients. A fertilizer formula, targeted towards the needs of a specific crop, may not reach the plant in the desired



proportions. The original composition may be modified, prior to the uptake by roots, through adsorption, fixation, leaching, volatilization, reduction, all processes which are governed by a combination of the chemical, physical and biological properties which characterize different soil groups. A number of examples are well known, for instance, the strong fixation of phosphorus by acid soils in the humid tropics which have high contents of iron and aluminium oxides; the low response to fertilizer applications

in soils which show aluminium toxicity; inhibiting growth conditions of iron toxicity in lowland paddies; the deficiency of trace elements in semi-arid highly calcareous soils; the difficulty of ensuring balanced plant nutrition in soils which are high in salts or sodium.

Knowledge of the different soils which occur worldwide, their characteristics and distribution, is now available (7) and ought to be used when planning a more efficient use of plant nutrients. General statements made about the management of nutrients in 'tropical soils', 'marginal lands', 'fragile soils' may be very misleading. Fertilizer recommendations should be more site specific and refer to real conditions at the farm level.



'External inputs in agriculture (primarily mineral fertilizers, pesticides and improved seed varieties) have been subject to debate because of the environmental hazards of high or excessive use. When managed well, external inputs do lead to greater yields and improved nutrient content. This can reduce the pressure to convert land to agriculture and improves food security. Few developing countries can therefore afford to forego the benefits of external inputs.

However, in developing countries, especially in Africa, input levels are generally low and sustainability problems are more often those of depletion rather than of pollution. Loss of soil fertility results from continuous 'mining' of plant nutrients without adequate replenishment. The age-old method of shifting cultivation - which made it possible to grow crops for a few years on nutrients derived from burning the forest - no longer meets the food demands.'

NEW DIRECTIONS FOR AGRICULTURE, FORESTRY AND FISHERIES, FAO 1994

### Is plant nutrition an environmental issue?



The intensification of agriculture has raised concerns about the use of 'agrochemicals', a term typically used to group both fertilizers and crop protection products. However, *pesticides* are 'biocides' - designed to control insects, fungi or weeds - while *fertilizers* are composed of nutrients which are essential for plant growth (11).

The increasing use of plant nutrients, both in mineral and organic forms, is being questioned on account of possible effects on the environment. It should be stressed that these effects may be both beneficial and hazardous, and that their actual impact depends less on the kind of plant nutrients than on the amounts and the way they are applied. The most significant benefit from improved plant nutrition has been the avoidance of widespread famines through the introduction of high-yielding varieties of wheat and rice in combination with an increased use of fertilizers and an expansion of irrigation. In countries with high population density, the shortage of arable land would not have permitted a comparable increase in production through horizontal expansion. Even in countries where land reserves are still available the expansion of cultivation is often at the expense of forested areas or marginal lands that are susceptible to different forms of degradation. Through improved farm practices, including integrated plant nutrition, the area of land under cultivation can sometimes be reduced.

A negative environmental effect is a progressive decline of soil fertility when produce is continuously removed without a replenishment of plant nutrients. This 'mining' of soil fertility is taking place in a number of developing countries, especially in sub-Saharan Africa where the yearly loss of nutrients is leading toward critical impoverishment (19). It is now generally recognized that the lack of adequate fertilization severely limits the agricultural production in sub-Saharan Africa.



'The adverse effects on the environment of the increased use of fertilizers and pesticides can be minimized if the process of intensification is carefully managed in the context of the potential offered by approaches such as Integrated Plant Nutrition Systems (IPNS) and Integrated Pest Management (IPM).

It is noted, however, that enhanced fertilizer use is a necessary ingredient of the move towards more sustainability in the areas where too little fertilizer use is associated with nutrient mining and soil degradation. This is the case in many of the countries of sub-Saharan Africa and the risk here is that the economic and policy environment may continue to be hostile to the adoption of practices to prevent soil nutrient mining.'

'FOOD, AGRICULTURE AND FOOD SECURITY - THE GLOBAL DIMENSION', FAO 1995



## Fertilizer nutrient losses

Increasing levels of nitrate reported in potable waters in a number of industrialized countries has been linked to the increased use of nitrogen fertilizers on agricultural land. Intensive research has shown that if N-fertilizers are applied at the correct time and in the right amount to a growing crop, then very little fertilizer nitrate remains in the soil at risk of being lost by leaching (17). The leaching of nitrates depends largely on water percolation following periods in which nitrate accumulates in the soil. Hence the likelihood of nitrate leaching in soils with high rainfall intensities and low water storage capacity. A remedy to nitrate leaching is improved farming practices which maximize crop uptake of fertilizer N and avoid fertilizer doses in excess of actual crop requirements. Soil testing provides the means of assessing precisely the needs of a given crop and to establish the amounts of fertilizers required to obtain a target yield. The risk of nitrate leaching is particularly high with applications of organic manure on account of its slow mineralization and the lack of synchronism with plant requirements (1).



Phosphates may be carried into surface waters through erosion. Increased concentrations of phosphates may cause 'eutrophication' and generate algal blooms with subsequent detrimental effects on aquatic life. Well balanced applications of P fertilizers and the control of erosion can prevent undue losses of phosphates from agricultural land.

'Information about the optimum use of fertilizers, which is obtained by soil analysis, is rarely available to small-scale farmers. Two ways of improving fertilizer effectiveness and reducing fertilizer run-off and leaching are to train farmers in plant nutrient management and soil conservation, and to improve marketing and credit facilities so that fertilizer can be applied at the right rate at the right time.'

*NEW DIRECTIONS FOR AGRICULTURE, FORESTRY AND FISHERIES, FAO 1994*

Under current use of potassium fertilizers very little K is expected to leach to the groundwater. In any case K in water has no known detrimental effects. Potassium is not normally a limiting factor to plant growth in natural waters so that concentrations of K do not cause eutrophication.

Where the high use of fertilizers has led to undesirable environmental consequences, the knowledge exists in most cases to remedy or minimize these effects (5). In countries with low soil fertility and low rates of fertilizer application, leaching and eutrophication due to fertilizers are unlikely to be a problem and in any case represent a minor issue compared with soil nutrient exhaustion.

## Does plant nutrition pay?



Improved plant nutrition will be adopted by farmers only if they perceive a return from direct costs and from inputs. Furthermore, for resource poor farmers in developing countries, returns are required within a short term - one to two years - in view of their uncertainty of survival from one year to the next (16). When economically feasible, plant nutrition practices are readily adopted by farmers since effects are tangible and benefits are obtained at the time of harvest. In such circumstances, providing farmers with information and advice will be an effective means of increasing production. But when cost/benefit ratios are unfavourable, technical assistance is in vain.



When crop prices are such that external inputs do not pay, efforts deployed in developing countries to enhance the use of mineral fertilizers are often discouraged or discredited. The solution is not, however, to deny farmers the use of inputs but, through public policy, to create the necessary motivation and the infrastructure necessary to give people access to the inputs they require. Cost saving measures, market systems, pricing policies, temporary subsidies, credit facilities, increased fertilizer use efficiency and improved extension play a decisive role. The fact that favourable conditions can be created and that spectacular results can be obtained has been shown in a number of developing countries. FAO's fertilizer programme, which has been in operation since 1961, has amply demonstrated what can be achieved with improved plant nutrition at farm level (10).

Economic benefits should not be generated at the cost of critical environmental hazards or of land degradation. Farmers should be encouraged and advised to adopt practices which are not only beneficial to them but also to society. However, farmers cannot be expected to bear the entire costs. Social benefits may accumulate over a long term and do not ensure a return to the farmer for the costs incurred from the initial year of implementation. Alley-cropping is an example of a widely publicized farm practice which, although possibly beneficial in the long term, has shown a very low adoption rate on account of limited returns within the short planning horizon of small farmers (4).

The economic aspects of plant nutrition are crucial for the adoption of improved practices. Since economic conditions are determined well beyond the farm level it is imperative that governments establish the appropriate policies, including a 'fertilizer strategy' to promote sustainable land use (8).

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'Depletion of soil nutrients is a critical constraint to food production in Sub-Saharan Africa. The projected growth in fertilizer use will be inadequate, given nutrient requirements for food production and for resource conservation. Fertilizer applications are low because of high prices (resulting from thin markets, lack of domestic production capacity, poor infrastructure and inefficient marketing systems), insecure supplies and the greater risks associated with food production in marginal areas.

Raw materials, capital investment, or technology do not appear to be critical constraints to future fertilizer production. Negative environmental and health consequences of fertilizer use and production must be avoided. In most developing countries, however, the problem is not excessive but insufficient fertilizer use.'

*A 2020 VISION FOR FOOD, AGRICULTURE AND THE ENVIRONMENT, IFPRI 1995*

### What about a package approach?



While balanced plant nutrition is recognized to be an essential prerequisite for increased agricultural output, it should be fully realized that it is only one of the production factors. It is obvious that in addition to plant nutrition due attention needs to be given to water supply, improved seeds, correct timing of sowing and planting, disease and pest control, adequate tillage, post harvest protection and economic motivation. Plant nutrition can have its full effect only if combined with other inputs. The same applies in turn to other improved practices, for instance, irrigation and pest control can have their full effect only if supported by adequate plant nutrition.



While an integrated 'package approach' is a more comprehensive way of increasing production, it often appears that they are beyond the capacity of the small farmer. The availability of different inputs is not always timely, the interaction may be difficult to synchronize and the total cost may be beyond the farmer's resources. The long term experience of FAO's fertilizer programme has shown that an initial emphasis on improved plant nutrition has often led to a progressive adoption of other improved practices. The quick response to fertilizer applications, which can be observed in the farmer's own fields, has been a convincing argument to subsequently introduce other inputs such as better seeds, pest management and more efficient water use. The 'pioneering' role of plant nutrient management has in many instances paved the way to a more holistic approach to farming.

'The agro-technical concept of IPNS has been enlarged to a holistic development programme promoting natural resource management through people's participation with the following main components:

- Diagnosis, through people's participation, of social, ecological and economic processes determining current soil productivity.
- Identification of integrated practices of organic recycling, inputs management, soil preparation and cropping patterns.
- Transfer of technology and human resources development.
- Exchange of experience through regional field programme networks.
- Promotion of farmers' organizations to upgrade natural resources management and to purchase inputs.
- Support for government strategies and policies related to plant nutrition towards sustainable agriculture.
- Collaboration with donor community, international research centres and non-government organizations.'

*INTEGRATED PLANT NUTRITION SYSTEMS, FAO 1995*

## Conclusions

- Agriculture performs a vital public function: it feeds the people of the world. Its challenge is to increase and sustain production in order to meet the demands of present and future populations while at the same time preserving and enhancing the quality of the natural resource base. These challenges are not conflicting, they can be complementary through good management and an efficient use of inputs.



- Effective management of plant nutrients is a major component of agricultural development. Nutrients removed by harvests must be replenished and it is necessary to enhance the fertility of soils which are low in nutrient reserves, to rehabilitate soils that have been depleted, and remedy other constraints which inhibit crop response to plant nutrition.
- Assessment of environmental risks must be based on factual information and take into account the trade-offs with the human needs for essential food supplies. Misuses which may occur in industrialized countries should not be invoked to penalize agriculture in developing countries where the level of inputs used is mostly far below critical levels.



- Efficient production obtained from land already under cultivation through improved plant nutrition discourages further deforestation and horizontal expansion onto marginal lands which are prone to degradation and desertification.
- Integrated plant nutrition is a useful approach to effective plant nutrient management. It promotes the combined use of various nutrient sources, especially those which can be mobilized locally by the farmers themselves. The benefit of organic inputs extends beyond their nutritional value, but they are not alone sufficient to replenish nutrients removed by crop harvests. The complementary use of mineral fertilizers is essential to sustain soil fertility and to achieve increased production.
- The economic aspects of plant nutrient management are of prime importance. Tangible returns to cost and labour are required and must be perceived in a short term horizon. Improved plant nutrition showing results within a cropping cycle can encourage other improved practices toward a holistic farm management.
- Since national economic conditions and the development of infrastructure are factors beyond individual farmers, the motivation for improved plant nutrition requires the support of strategic agricultural and fertilizer policies at government level.
- The fertilizer industry is committed to the promotion of both efficient and responsible use of its products. Properly applied fertilizers contribute to meeting the demand for food and the conservation of soil and water resources by sheltering land from deforestation and inappropriate use.

## References

- 1 Addiscot, T.M., Whitmore, A.P. and Powlson, D.S., 1991. Farming, Fertilizers and the Nitrate problem. C.A.B. International, Wallingford, 170 p.
- 2 Borlaug, N.E. and Dowswell, R., 1994. Feeding a human population that increasingly crowds a fragile planet. International Society of Soil Science and Mexican Society of Soil Science. Transactions 15th ISSS Congress, Mexico, 15 p.
- 3 Buringh, P. and van Heemst, H.J.D., 1977. An estimation of world food production based on labour-oriented agriculture. Centre for World Food Market Research, Wageningen, 46 p.
- 4 Chin Ong, 1994. Alley cropping - ecological pie in the sky? Agroforestry Today, July - Sept. 1994. ICRAF, Nairobi.
- 5 Dudal, R. and Byrnes, B.H., 1993. The effects of fertilizer use on the environment. In: Van Reuler, H. and Prins, W.H. (Eds.), 1993. VKP, Leidschendam, pp. 141-154.
- 6 Dudal, R. and Roy, R.N., (Eds.), 1995. Integrated plant nutrition systems. FAO Fertilizer and Plant Nutrition Bulletin No.12. FAO, Rome, 426 p.
- 7 FAO, 1971 - 1981. FAO/Unesco Soil Map of the World, scale 1:5,000,000. Unesco, Paris, 10 Volumes and 19 map sheets.
- 8 FAO, 1987. Fertilizer Strategies. FAO, Rome, 148 p.
- 9 FAO, 1995. World Agriculture: Toward 2010. N. Alexandratos (Ed.), John Wiley and Sons Ltd., New York, 448 p.
- 10 FAO, 1989. Fertilizers and Food production: the FAO Fertilizer Programme 1961 - 1986. FAO, Rome, 111 p.
- 11 FAO, 1992. FAO Policies and Actions: Stockholm 1972 - Rio 1992. FAO, Rome, 88 p.
- 12 FAO, 1994. New Directions for Agriculture, Forestry and Fisheries: Strategies for sustainable agriculture and rural development. FAO, Rome, 63 p.
- 13 Greenland, D.J. and Szaboles, I., (Eds.), 1994. Soil Resilience and Sustainable Land Use. C.A.B. International, Wallingford.
- 14 IFA, 1992. Sustainable agricultural systems for the twenty-first century : the role of mineral fertilizers. International Fertilizer Industry Association, Paris, 16 p.
- 15 IFPRI, 1995. A 2020 Vision for Food, Agriculture and the Environment. IFPRI, Washington, 50 p.
- 16 Izac, A.M.N., 1994. Ecological-economic Assessment of Soil Management Practices for Sustainable Land Use in Tropical Countries. In: Greenland D.J. and Szaboles, I., (Eds.) 1994. C.A.B. International, Wallingford, pp. 77-96.
- 17 Johnston, A.E., 1994. The efficient use of plant nutrients in agriculture. International Fertilizer Industry Association, Paris, 14 p.
- 18 McCalla, A. F., 1994. Agriculture and food needs to 2025: Why we should be concerned. CGIAR, Washington, 29 p.
- 19 Smaling, E.M.A., 1993. Soil nutrient depletion in Sub-Saharan Africa. In: Van Reuler, H. and Prins W.H., (Eds.), 1993. VKP, Leidschendam, pp. 53-67
- 20 U.N., 1996. The United Nations Systemwide Special Initiative on Africa. U.N. New York, 38 p.
- 21 UNCED, 1992. Agenda 21. U.N. New York.
- 22 Van Reuler, H. and Prins, W.H. (Eds.), 1993. The role of plant nutrients for sustainable food crop production in Sub-Saharan Africa. VKP, Leidschendam, 232 p.

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