Global assessment of the situation of fertilizer best management practices

A. Krauss
IFA Consultant, Schoenenberg, Germany; admakrauss@t-online.de

Global warming, protecting the environment and safeguarding natural resources are of great public concern. In consequence, agriculture is becoming increasingly regulated with, in the case of fertilizers, restrictions on how much plant nutrient should be used and how it should be applied. The global fertilizer industry as the major source of plant nutrients is obliged to assist its clients, the farmers, by providing the means and tools to enable them to best manage nutrients.

There are countless fertilizer recommendations aiming to increase farm output and income and - to a certain extent – also to protect the environment. However, the wide array of recommendations is certainly not conducive to effective communication with the public and with legislative bodies when further rules and regulations regarding agricultural production and fertilizer use are being formulated and implemented. What seems to be needed is a proactive response, with one voice, and a forward-looking program in which a framework is given on how to manage fertilizer nutrients most effectively and to protect the environment, as well as providing the means for income generation and the production of sufficient and affordable food, feed, fiber and energy.

Since agriculture is confronted with continuously changing demographic and agronomic developments, the framework for best management of fertilizer nutrients has to be a living document, flexible and amenable to revision and updating.

Some of the major demographic challenges can be summarized as follows:

- The global population is still growing and, thus, also the demand for food in general;
- Urbanization is still advancing, accompanied by dietary changes, towards more animal protein, processed food and higher quality food;
- The population is aging rapidly, a population that requires less calorific food but more fruits and vegetables;
- Consumers increasingly demand more "environmentally-friendly food"; the "bio" aspect is assuming a predominant role when selecting food at the market;
- Consumers, especially in industrialized countries, are becoming increasingly suspicious on how their food is produced. They ask for greater transparency and traceability, which requires more documentation and recording on the part of the farmers;
- Last but not least, the growing globalization in food trade not only transfers more plant nutrients across national borders, but consumers want to impose their local rules and regulations on farmers abroad;

The agronomic changes are as challenging as the demographic developments:

- The cropped area is declining because of increasing urbanization, and this calls for increasing productivity in order to compensate for land loss;
- Access to irrigation water also is declining with the consequent need to improve water use efficiency;

- Land productivity is starting to decrease, predominantly caused by unbalanced fertilization and resulting soil nutrient mining;
- Land degradation, declining water tables and desertification in certain countries restrict further progress in yield and quality;
- A high degree of wastage of agricultural produce requires even higher output to meet growing demand;
- Emerging competition for land between food crops and energy crops also results in the need for higher yields of food crops from the remaining land;
- Labour shortages in agriculture leads to a demand for "smart inputs" (e.g. nutrients, growth regulators, repellents, etc. in a single application) and increased mechanization.

The standard of crop production and nutrient management varies considerably worldwide

There is a close relationship between the appropriate fertilizer recommendations and nutrient management and the level of crop production.

Agricultural systems may be classified approximately into four groups, as follows:

1. **Subsistence agriculture**
   Self-sufficiency with or without a small surplus for the market is the dominant management structure. Low educational levels and the low purchasing power of the farmers result in poor nutrient management. If fertilizers are used at all, their use is often unbalanced and the rate too low. The plot sizes are often too small for a standard bag of 50 kg fertilizer. A resulting poor crop canopy results in nutrient losses from erosion and/or run-off. Widespread soil nutrient mining reduces fertility, and the usually very low nutrient use efficiency results in the possibility of losing a substantial part of the applied N in the form of atmospheric emissions.
   Fertilizer recommendations are usually very simple (bags per acre). A lack of knowledge and insufficient advice aggravate poor nutrient management. Irregular fertilizer supply, uncertain in time and quantity, comprising mostly straight fertilizers with a high nutrient concentration, make precise nutrient management difficult. Lack of funds, unfavourable crop/fertilizer price ratios are further obstacles to the needed application of nutrients. The absence of fertilizer regulations permits the sale of adulterated and/or less effective materials.
   Public advisory services are often non-existent or ineffective; assistance from the private sector and/or international agencies is normally sporadic and not ubiquitous.
   More advanced fertilizer recommendations in form of fertilizer best management practices (FBMPs) in general are not issued, although international research centres develop easy-to-handle management tools such as leaf colour charts or omission plots to improve nutrient use efficiency.
   Most of the developing countries, especially in Sub-Saharan Africa, belong to this category.
2. **Crop management in transition, often mixed with commercial estate/plantation farming**
   Prominent representatives of this group of countries are Argentina, Brazil, Indonesia, but also China, India, countries of West Asia/North Africa and Russia. The commer-

cial sector is export-oriented and confronted with strict quality norms and non-tariff barriers.

The focus on exports introduces the quality factor, which, in turn, affects nutrient management. More care is taken to estimate the nutrient budget although the nutrient balance often remains inadequate because of the large quantities of nutrients removed in the exported crop. Food crops are frequently under-fertilized. The nutrient use efficiency remains rather low in this category, resulting in substantial nutrient losses to the environment. Management of crop residues is still rather erratic.

Better advisory services, especially those provided by the private sector, aim to improve the nutrient balance. The public sector in contrast appears to be weak. More advanced site- and crop-specific fertilizer recommendations based on field trials are available, although there is still limited access to soil tests and plant analysis.

Fertilizers are, in general, better available in quantity and timeliness, and are more affordable. Fertilizer regulations are already in place in a range of countries, and these provide better protection for the farmers. However, imports and prices are still controlled, especially for straight N, P and K fertilizers. The use of appropriate NPK mixtures is limited as is the availability of secondary and micronutrients. In some countries, there are still legislative restrictions and/or slow approval procedures for the use of new fertilizers such as custom mixed fertilizers and organic products.

3. **High-tech farming based mostly on voluntary adoption**

Farmers in this category, as in the USA and Canada, aim for sustainable, maximum production, in terms of both yield and quality. Nutrients are applied to improve both plant growth and quality. Care is taken with the nutrient budget and to maintain well balanced fertilization. High yields and supply of crops for the market result in a high nutrient turnover and a large export of nutrients removed with the harvested crops.

The environmental aspect of nutrient management is receiving increased attention. Improved control of nutrient losses to the environment is favoured by synchronizing nutrient supply with the crop's nutrient demand. More care is being taken with crop residue management. Also, the integration into nutrient management of nutrients supplied from organic sources is becoming common practice.

Site- and crop-specific fertilizer recommendations based on soil tests and plant analysis are widely available. "Precision" nutrient management is becoming widely adopted.

There are hardly any limitations on the availability of fertilizers, in terms of type, quantity, quality and timeliness of supply. Farmers usually have good access to custom mixed fertilizers.

In general, fertilizer use is fairly well balanced because, on one hand, of the high level of instruction of the farmers and, on the other hand, the wide spectrum of available information. Access to the internet is common practice. The availability of high-quality and custom mixed fertilizers favours the application of nutrients in a well balanced manner. However, economic considerations and mounting pressure from the public, in particular from environmental groups, are impacting fertilizer use.

Fertilizer advisory services are predominantly based on a strong private sector, which offers a wide range of information and management tools. The public sector is still well structured and reputed but is tending to withdraw.

Legislative intervention is increasing, although less restrictively than in EU. The focus is on the statutory control of the environmental fate of nutrients, especially of N and P.

4. **High-tech farming with substantial government involvement**
   This category is particularly prevalent in the EU countries, as well as in Australia and New Zealand.
   The profitable production of top quality crops is the aim of most farmers also in this in this category. However, increasing social and administrative pressure and regulations on farm management and a rapidly growing market for so-called "bio-products" increasingly impact nutrient management in crop production:
   - Production has to be compatible with environmental considerations and, in order to comply with regulations, the production of "healthy" food may even be at the expense of yield;
   - Fertilizer use is under strict control in terms of time of application and quantity; exceeding the permitted levels of N and P can result in a fine;
   - The documentation and monitoring of nutrient use and movement is becoming mandatory, based on fertilizer recommendations and information on the nutrient contents of crops and manure;
   - Environmental groups are becoming more involved in nutrient management measures;
   - The integrated approach to farm and nutrient management, i.e. the integration of plant protection, irrigation, animal husbandry, social welfare, etc., is becoming common practice.

   The level of education of the farmers is usually good; they have access to a wide spectrum of information, and the availability of high quality and custom mixed mineral fertilizers helps farmers to comply with statutory requirements and consumer demand.

It is the expectations of the public that encouraged the preparation of codes of conduct in the form of fertilizer best management practices.

Attempts have been made to prepare manuals which explain how to best use fertilizers in a way that is efficient and economic and that respects the environment. A range of recommendations for FBMPs has been issued, substantiated by research and tested through farmer implementation, adapted to local conditions. Some examples are:

- the Australian "Cracking the Nutrient Code";
- the New Zealand's "Code of Practice for Fertilizer Use";
- the French Reference Code for "Agriculture Raisonnée";
- the European Integrated Farming Framework by EISA;
- the UK "Whole Farm Nutrient Plan";
- Fertilizer Best Management Practices issued by FAR, USA;
- the TFI/PPI Fertilizer Product Stewardship, USA.

Similar documents are under preparation for example in Brazil, China, India and Russia. There is no knowledge of the existence of such documents in areas with a predominantly subsistence agriculture.

It is common practice for FBMP documents to be developed in a concerted manner with the different partners. For example, the UK "Whole Farm Nutrient Plan" has been jointly developed by the private sector (AIC, PDA), the relevant governmental

body (DEFRA), environment agencies (FACTS) and integrated farming organizations (LEAF).

The objectives of those country/region-specific FBMPs can be summarized as follows:

- To create understanding and awareness of the fate of nutrients, the risks linked to nutrient use, the potential of nutrients to pollute the environment and the misuse of natural resources. This refers in particular to:
  - leaching of nutrients, especially nitrate,
  - accumulation of nutrients due to overuse and/or inadequate and uneven application,
  - nutrient loss through run-off and erosion,
  - atmospheric losses of nutrients, especially volatile N forms,
  - soil nutrient mining due to imbalanced fertilization, i.e. removing more nutrients from the soil than are added through mineral and organic fertilizers.

  Apart from harm to the environment, the loss of nutrients is also a financial waste, a loss of potential yield and income and higher costs for society as a whole, for example in water treatment or mitigating the impact of global warming.
- To mitigate physical risks associated with operational activities, such as transport, loading/unloading, storage and application.
- To take account of the risks associated with agronomic activities. In short, fertilizer nutrients have to be applied following the guiding principles:
  - right product(s),
  - right rate,
  - right time,
  - right place.
- To take account of environmental and social objectives, for example concerning groundwater, surface water, soils, neighbourhood, biodiversity, air and farm produce.

The adoption of FBMPs differs according to the farm management systems:

- For farms that are subject to tight statutory regulation, FBMPs have the advantage of being integrated into quality assurance programs, land use policies and support to meet regulatory requirements. Fertilizer best management practices also promote the traceability of nutrients and transparency. It can also be argued that FBMPs can support acceptability on the global market.
- For farms operating under less stringent statutory regulations, acceptance and adoption depend on whether FBMPs are economically feasible and logistically compatible with the farm systems and with enterprises that compete for labour, management and resources. Awareness that FBMPs could be a management tool for increased fertilizer use efficiency, improved farm income and reduced risks supports their adoption. The farm size and the educational level of the farmer also seem to be related to their acceptance.
- Bureaucracy, countless documentation, auditing and the need to ensure economic viability while reducing nutrient loss and minimizing environmental impacts are substantial restraints to the adoption of FBMPs.
- Resistance to change from traditional ways that are perceived to have worked well in the past also constrains the adoption of the more advanced FBMPs.

- For countries with a subsistence agriculture and those in transition, there is a whole range of constraints to the adoption of FBMPs. Some of these are:
  - the huge number of recipients,
  - widespread illiteracy, misinformation and poor education,
  - lack of knowledge, combined with inefficient extension services,
  - the side-effects of misuse are not known,
  - other constraints such as lack of irrigation, pest and disease control, labour availability etc.,
  - farmers' limited financial resources,
  - often inadequate returns due to an unattractive price/cost ratio,
  - unsatisfactory fertilizer supply in terms of kind, quality and timing,
  - often a high diversity of crops and cropping systems, climate and soils,
  - shortage of funds for soil and plant testing, soil mapping and research,
  - lack of private-sector involvement in advisory services and the education of farmers.

Despite the constraints described above, there is also a wide range of benefits to be obtained from the development and adoption of FBMPs, since they:

- Help to optimize and economize on fertilizer use by reducing losses and thus improving use efficiency;
- Contribute to wealth creation for the country and individual farmers by developing and implementing new nutrient management techniques that realize the agricultural potential in a sustainable way;
- Translate plant nutrient research into best practice;
- Create new technologies, knowledge and value-added products that optimize sustainable agricultural output;
- Contribute to a better understanding of the relationship between nutrient management and land use;
- Provide a model for balancing nutrient inputs, agricultural outputs, environmental sustainability and people's health and well-being;
- Improve the relationship between the farmer and the consumer by creating confidence through transparent operations;
- Create confidence in the fertilizer industry as a sector that takes into account the economic expectations of its clients (the farmers) and the environmental concerns of the public opinion;
- Provide access to high value niche markets;
- Contribute to improved soil health and hence sustainable crop productivity.

Is a global fertilizer best management practices framework feasible?

It is clear that, while FBMPs have a useful function in the country where they have been developed, it is questionable whether they are transferable to countries with a different agro-ecological situation. However, there is a need to communicate to the public and politicians, with one voice, the concern to protect the environment and to safeguard natural resources, in particular with respect to nutrient management.

It is therefore proposed that a global FBMP framework should be developed as a document that demonstrates the concern and commitment of the fertilizer industry as regards environmental issues. Just as industry has ISO standards to make production, supply and services safer, more efficient, transparent and environmentally friendly, a global FBMP framework could fulfill an analogous purpose in agriculture, as a kind of quality management system.

The FBMP framework should also serve also as a guide to the development of regional FBMPs based on science and site- and crop-specific conditions. They could contribute to income generation, rural development and food security.

The regional FBMPs derived from the framework should be based on the following principles:

- They should be developed in a concerted action by all stakeholders, i.e. the fertilizer industry through its associations, governments, research, extension, farmers' organizations and environmental groups;
- Government participation should help to prevent stringent, disproportionate and exaggerated statutory directives and regulations with respect to fertilizer use;
- They should integrate nutrient management with related agri-disciplines (e.g. irrigation, pests and disease management);
- They should contain provisions for training (both for farmers and dealers), monitoring, audit and review systems, in order to be traceable and transparent in their operating and agronomic activities.

Regional FBMPs derived from the global framework should take account of the following points:

- Be specific enough to cope with diverse crop and climatic conditions;
- Be flexible and amenable to revision and updating;
- Be based on good research and sound data;
- Meet regulatory requirements;
- Contribute to protection of the environment and conservation of natural resources.
- Adoption should be in the context of the economic sustainability of crop production;
- The introduction of FBMPs should be accompanied by appropriate educational material and programs.

In the spirit of sustainable product stewardship, the fertilizer industry could play a leading role in the development of the framework and the consequent FBMPs throughout the world. In regions with predominantly small farms and/or low education level (in particular in developing countries), this should be by:

- Providing fertilizers in a rational and economic way in the context of the financial limitations;
- Promoting legislation and regulations that permit liberalization of the fertilizer sector.
- Working closely with governments to liberalize policies and thus facilitate the development and sale of custom mixed fertilizer grades and their supply to farmers. This would provide economic benefits and would be conducive to environmentally friendly practices;

- Fostering through industry's associations, in close contact with extension services and research entities, further education, training, demonstrations, field days, field trials, etc.;
- Providing information material through various channels and platforms (printed, electronically, media);
- Assisting, through their outlets, the monitoring and recording of operational and agronomic activities related to nutrient management;
- Promoting soil testing and plant analysis, the establishment of soil fertility indices and maps, etc.;
- Providing a platform for educating farmers, which could be used also by other sectors.

Conclusion

There is an evident need to express with a single voice the concern of the fertilizer sector to meet the expectations and demands of the public and to respect statutory rules and regulations. Individual fertilizer recommendations do not serve this purpose. This also applies to country- or regional-specific FBMPs, in view of their local approach. A global framework for individual FBMPs, developed in a concerted way with the other stakeholders, could provide a guiding document to policy makers when formulating legislation on agricultural and environmental issues. This document could also act as a proof of good stewardship in relation to the production, distribution and use of fertilizers. And last but not least, a global framework could improve and strengthen public confidence that agriculture and the related agri-business sectors, including the fertilizer industry, aim to provide the consumer with affordable and healthy food while preserving the environment and natural resources.

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General Principles, Strategy for their Adoption and Voluntary Initiatives vs Regulations

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28, rue Marbeuf, 75008 Paris, France
Tel: +33 1 53 93 05 00 Fax: +33 1 53 93 05 45/ 47
publications@fertilizer.org www.fertilizer.org