THE USE OF FERTILISERS AND WATER QUALITY.

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Fertilizers are plant nutrients and their role is to maintain or increase plant growth in agriculture, horticulture or forestry. There are positive environmental aspects: fertilizers correctly used help maintaining the biological production and they stabilize the production system by keeping the nutrient balance. Soil degradation and erosion can be reduced. Another important aspect is that a high and reliable agricultural production reduces the need for agricultural land, which leaves more room for forests, pasture och nature.

The negative environmental aspects are more discussed: outflow of nitrate and phosphate to waters, causing both quality problems in drinking water and eutrophication.

It must be recognized that the outflow of nutrients from agroecosystems is governed by the whole system, involving crop rotation, soil management, management of harvest residues, use of organic manure and fertilizers. Typical nutrient data for a North European (Swedish) situation are shown in table 1.

Table 1. Nitrogen and phosphorus in the topsoil.

	Nitrogen	Phosphorus
Total contents in topsoil, kg per hectare	6000	2000
Removed by an average harvest, kg per ha and year	100	20
Added in fertilizers and/or manure, kg per ha and year	100 - 120	15 - 25
Losses to waters, kg per hectare and year	25	0.3
Losses, tentative environmental goal	10	0.1 - 0.2

The figures in the table illustrate that a major issue is to manage the nutrient bank of the soil from where nutrients are both released and absorbed or fixed. Measures to reduce the outflow of nutrients from agriculture must be integrated with the whole system management, of which the fertilizer use is one part.

The fertilizer industry is taking a very active part in this work, both through industrial organizations (EFMA, IFA) and by individual companies. Three goals can be formulated:

1. There should be no direct outflow of nutrients from applied fertilizer.

2. The input of fertilizer should be adapted to the requirements of the system considering both shortterm efficiency and longterm stability.

3. The agricultural management should minimize nutrient losses to the environment

The following is a summary of activities by Hydro Agri with focus on the Swedish scene.

Main issues in reduction of losses.

An important background is that research and experiments have shown that for normal agricultural situations in Northern Europe the nutrient outflow is little affected by nutrient input as long as the amounts do not exceed the crop requirements. Consequently, correct evaluation of the nutrient situation is important also in relation to the environment.

Integrated use of site-specific data for adapting the fertilizer use.

Soil data (nutrient analysis, soil type, nutrient balance account) and crop data (normal yields on the site, actual crop stand parameters) are used to formulate a fertilizer recommendation. The consideration of all parameters is facitilitated by a computerized system: HydroPlan.

The site-specific concept is now developing into a new phase, precision agriculture, where the variations within a field is considered. Tools are: ground positioning systems (satellite based) and field and yield mapping procedures.

Annual adaptation by complementary fertilizer dressings governed by direct crop need diagnosis.

No calculation at the start of the vegetation season can account for the uncertainties of weather, diseases and other variable factors affecting crop growth and yield formation. Therefore, a system allowing annual adaptation of nitrogen at a later stage is important. There are two steps, both starting with a somewhat low and safe estimate of crop nutrient demand:
1. Base: visual judgement, crop stand evaluation.
2. Base: measurement of nutrient status. Plant analysis can be used. As an easier field method Hydro Agri is introducing a system with a chorophyll meter (Hydro N-tester) which is calibrated by means of field experiments.

Nutrient balancing.

Fertilizers should not be regarded as a chemical product increasing yields. Fertilizers are part of the nutrient turnover in the agroecosystem and should be seen in that context. There are system constraints to consider. For instance: positive balances of phosphorus might be needed in a build up phase of poor soils, but in the long run continuous positive balances are an environmental danger signal to consider.

Our work in the industry is centered around two topics:
1. To calculate, evaluate and discuss nutrient balances in the experimental development work and use the knowledge for development of efficient fertilizers and efficient practices. A follow up is active support of frontline work at farm level (Integrated farming project).
2. To bring forward the concept : ecological base for fertilizer recommendations and fertilizer use.

Farm management improvement.

This is not the primary task of the fertilizer industry, but we feel that a positive involvement is of importance for the total development. Two examples:

1. Promotion of cover crop systems. We started experimental work on this subject already more than 20 years ago. It is one of the most efficient methods for reducing nitrate outflow, and we will do our share in promoting this practice.
2. Development and promotion of fertilizer placement as a method improving nutrient efficiency.

Recycling development.

At present we work along two lines, one passive and another active:
1. Fertilizers should be a complement to and not a substitute for recycling nutrients. Recycling should be promoted and not be seen as a competitor.
2. Active development of products and processes for recycling nutrients from waste. Active development work is in progress, but yet no such products have been put on the market.

Achievements.

The issues mentioned above are in good progress. Of course, our efforts are only a complement to measures promoted or enforced by official agricultural bodies, but a united approach is important.

It would have been nice to report hard data showing reduced nutrient outflow from agriculture to waters, but so far the effect of the positive development is not visible against "natural" fluctuations in river transport data.

What can be reported, however, is the following trends for the last decade:

* A continued positive yield development in spite of constant (or reduced) nutrient input. This means an increase in the nutrient utilization.

* A reduction in phosphorus use to a level corresponding to replacement of the offtake by harvested products. A certain degree of stability has been reached.

In the long run such developments will result in reduced outflow from the agricultural system to waters. In combination, increased knowledge and awareness of the influence of soil management procedures on nutrient outflow will greatly contribute to such a development.