

## Crop Nutrient Supply in a Sustainable Agriculture

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After the second world war agricultural production in the developed regions of the world showed a very high annual growth rate for an unprecedentedly long period. However, since the end of the sixties it has become more and more evident that industrial agriculture causes ever increasing damage to the natural environment, on different scales in different regions, and it has been gradually recognized all over the world that new ideas and methods must be introduced into this type of production system.

In contrast with industrial agriculture, the rapidly developing trend towards biological or organic agriculture condemns the permanent use of chemicals in agricultural production, without taking into consideration the consequences this method would have for the food supply of mankind.

It is now evident that urgent steps must be taken to provide sufficient nourishment for the increasing population of the world, at the same time taking great care to protect the natural environment of the earth for future generations.

This new concept of agricultural management has been aptly named by MEADOWS as sustainable agriculture.

It is to be sincerely hoped that the current "Seminar on Technologies for Sustainable Agriculture" will prove to be a milestone in the establishment of the basic principles of this new system, a system aimed at a world-wide agriculture which is both productive and non-damaging to the environment.

In order to gain a better understanding of the place and role of sustainable agriculture in the historical development of agricultural systems in Eastern Central Europe, let us cast a glance at the development of these systems over the last fifty years.

This period has witnessed three general systems of agricultural management.

1. Up to the end of World War II the natural system of agriculture prevailed in this region. The central figure in this system was the peasant on his small-holding, using centuries-old methods of cultivation. These farms were self-sufficient, providing food for the family and feed for the livestock, and using up all the by-products as feed, manure or as a source of energy. This type of farm was an independent part of the general economy and maintained a healthy balance in the environment, so it can be regarded as a truly "sustainable" agriculture.

There were, however, definite limits to this system: yields were low, showing little change throughout the first half of the twentieth century,

and a very low proportion of the goods produced were actually marketed.

2. After World War II the political, social and economic systems in this region underwent a fundamental transformation, leading to a very changed atmosphere for traditional agriculture. Private farms were replaced by state farms and cooperatives in all the European socialist countries with the exception of Poland and Yugoslavia. Horses and oxen practically disappeared, giving way to tractors, and mineral fertilizer took the place of manure as the main factor in supplying the soil with the necessary nutrients. There was a sharp decline in the number of people employed in agriculture; the proportion of total agricultural production designed for marketing substantially increased; and the possibilities for utilizing by-products became much reduced.

It is perhaps worth mentioning that during the first phase of this transformation, the countries in this region /namely Poland, Czechoslovakia, Hungary, Romania, Yugoslavia, Bulgaria and the GDR/ represented a special case. Whereas in other regions of the world /America, Europe, Asia, etc./ agricultural production showed an annual growth of 2% during the quarter-century from the mid-thirties to the early sixties, the average growth rate in Eastern Europe was only about 0.7%, one third of the world average. Consequently, at the beginning of the sixties these countries were plagued by food shortages which caused ever deepening social and political problems.

The respective governments therefore initiated comprehensive programmes for the rapid development of agriculture. In Hungary, too, a long-term development programme with a sound political, economical and material basis was accepted and endorsed by the appropriate party and government authorities and has been successfully executed over the last quarter of a century. As is well-known, plant production yields doubled between 1960 and 1980. The food supply available to the population fully satisfies both qualitative and quantitative needs, and the export of surplus agricultural products is a major factor in maintaining an equilibrium in the foreign trade and financial balances.

The factors which promoted this rapid development, matched only by Holland over the past decades, were as follows:

- Mineral fertilizer consumption increased eightfold between 1960 and 1975; mineral fertilizers now represent about 75% of the total nutrient supply in plant production, as opposed to 10% at the end of the forties.
- A system of chemical plant protection has been implemented, involving both aerial and terrestrial distribution.
- Traditional plant varieties have been replaced by new ones with much higher productivity, but also greater sensitivity to diseases and to disturbances in the nutrient supply.
- Production has been fully mechanized, making agriculture one of the main consumers of liquid fuel.

However, this enormous transformation has had not only favourable, but also adverse consequences.

Agriculture has lost its independence, becoming more and more dependent on industry, foreign trade and other sectors of the national economy. At present, around 60% of the basic materials for agricultural production are of non-agricultural origin /chemicals, fuel, energy, etc./.

In the mid-sixties, when agriculture emerged from half a century of stagnation, nobody realized what serious consequences this development would have for the natural environment. Hungary was not alone in this respect: the general opinion in East and West, and also in the developing regions, was that the era of continuous, rapid economic development based on cheap, in-

exhaustible supplies of raw materials and energy, would last indefinitely. No reference whatsoever was made to the environment.

During the late sixties and early seventies mankind received two serious shocks:

- the first was the realization that, as a consequence of the exponential growth of industrial and agricultural production, combined with the demographic explosion and other factors, the environment had suffered severe damage in various respects in different parts of the world;
- the second was the explosion in oil prices, which starkly illustrated the fact that the natural resources of the planet are limited and will eventually be exhausted. As a consequence of this, energy prices have increased more than tenfold over the last decade, and the prices of other raw materials have shown a similar, though more moderate trend. The illusion of an inexhaustible supply of cheap raw materials has been dispersed once and for all.

Adverse effects have gradually made themselves felt in Hungarian agriculture, too. The top layer of groundwater has become more and more polluted, partly due to the incorrect use of chemicals in agriculture, and partly by the effluents from large-scale stock farms. The pH value indicating soil acidity has decreased, leading to a deterioration in the conditions for microorganisms. The humus content has been reduced in many types of soil as the result of the unbalanced use of mineral fertilizers, combined with the burning of millions of tons of straw in the fields.

There has been rising criticism of the agricultural production system on the part of ecologists and environmentalists, but agricultural scientists and farm managers have also been looking for a better system, whereby agriculture can retain its productivity without causing irrevocable damage to the environment.

3. These considerations indicated the need for a new system of agricultural management which:

- would be better adapted to the natural environment;
- would utilize by-products such as straw in a natural rotation, instead of burning them in the field, thus increasing the organic matter content of the soil and reducing the need for mineral fertilizers; or which would alternatively use them as feed;
- would use part of the by-products for energy production; and
- would lower production costs.

The new system, which will hence be referred to as "sustainable agriculture", is now in the process of formation. Certain constituents of the process have already been introduced to varying extents in a number of co-operatives and state farms, but the fully fledged system has not yet evolved in Hungarian agriculture.

The basic precondition for the introduction of such a system would appear to be a radical change in the present one-sided, technocratic attitude, which thinks only in terms of production targets and the material means of production. This attitude should be replaced by a consideration of the global agrarian ecosystem, the various constituents of which are influenced by human activity. A thorough examination must be made, in cooperation with experts from the relevant branches of science, on the consequences of different agricultural and related activities. In addition to short-term aspects, consideration must also be given to the long-term consequences of various actions.

Any system of sustainable agriculture must include the following major elements:

1. A competent method for planning the crop nutrient supply, which should be implemented at plot level, so that virtually every inch of the cultivated area receives the exact quantity and quality of nutrient supply required to achieve the desired crop yield, taking into consideration the nutrient content already present in the soil. It is not mineral fertilizers in themselves, but their misuse which causes damage to the environment.

The general monitoring, analysing and advisory system necessary to check the consequences of pollution in soil, water and air, to provide adequate information on soil quality and nutrient content, and to give recommendations on the appropriate crop nutrient supply, has been set up as a network of agrochemical and plant protection stations which check every plot of arable land every third year.

2. The provision in the soil of the biological, chemical and physical conditions optimum for the activity of microorganisms. One of the major problems in this respect is the need to reverse the trend in soil pH and to prevent any further expansion of the acidification process. At present acidic soils make up more than a third of the total arable area. The reasons for this increase in the acidification process are acidic rain, the use of mineral fertilizers, the increasing extraction of lime from the soil with the harvested crop, etc. It will be essential to set up a long-term liming programme, within the framework of which approx. 2 million tons of lime must be distributed annually. Failing this, the decreasing pH value will soon reach a critical level where there is a sharp decrease in the activity and composition of microorganisms, leading to a rapid reduction in the efficiency of production.

3. In order to ensure satisfactory living conditions for the microorganisms, the soil must be supplied with the necessary organic matter. The importance of organic matter, which was recognized in the natural system of agriculture, has gradually been forgotten in the industrial agricultural system, with the consequence that more and more trace elements are required to complement the mineral fertilizers, the efficiency of which is relatively low in the absence of the necessary organic matter. The current technology must be improved in two respects: first, renewed importance must be attached to organic manure, which not only provides the organic matter necessary for the soil but also supplies various macro- and microelements required for plant nutrition. Secondly, instead of being burnt in the field, the straw should be ploughed back into the soil, thus enriching the humus content.

4. Mineral fertilizers of the correct quality and composition must be made available, together with equipment and methods for distributing the fertilizer as efficiently as possible. The provision of adequate fertilizers through imports or domestic production is mainly the task of the appropriate government bodies, while efficient distribution must be solved on the farm. In many cases the inequality of distribution is as high as 30%, due to imperfections in the equipment and in some cases to a lack of skilled labour. This means that parts of the soil are insufficiently fertilized, while on other areas the excess fertilizer causes damage to the environment.

5. An annual 40-45 million m<sup>3</sup> sewage are produced by state and cooperative livestock farms. This is estimated to contain around 125 000 t nutrients which could play a valuable role in crop fertilization, but is at present wasted. In addition, the untreated sewage is harmful to the environment. The solution promoted by the Ministry of Agriculture and Food is a radical change in the present liquid technology and the reintroduction of the practice of bedding. A complete change in the technology would require

enormous investments, so the liquid systems must be expanded to include technologies whereby the useful components of the sewage can be saved and the sewage itself purified. Such technologies are readily available.

6. Finally, the cultivated area must be more rationally utilized. This is a complex task, one aspect of which will be presented as an example. At present there are significant differences in yield between the main branches of plant production, as shown in Table 1.

Table 1  
Composition of plant production in Hungary, 1895-1980

Production branch	Yield in grain units per hectare <sup>+</sup>		
	1895 /1891- 1900/	1945 /1941- 1950/	around 1980
Horticulture	18	22	65
Arable land	15	15	38
Grassland	7	7	7

<sup>+</sup> 1 grain unit = 100 kg

Grassland constitutes 18% of the cultivated area, but receives no mineral fertilizer, as this is concentrated on horticultural and arable areas. Consequently, from the point of view of environmental protection, it is somewhat misleading to talk of the average use of fertilizers in plant production. In future, grasslands should be more efficiently utilized and the nutrient supply more equally distributed over the cultivated area. Considering the fact that the main aim in improving grassland utilization is to increase the number of cattle for meat production, it is evident that natural fertilizers will make up an increasing proportion of the total nutrient supply.

This is just one of the many ways in which land utilization could be rationalized.

Six aspects of the sustainable agriculture system have been discussed here, but there are obviously many other problems requiring investigation if appropriate methods and technologies are to be found to fit the specific conditions of any given area.