AGROTECHNICAL MELIORATION AND FERTILIZER

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Summary

One should bear in mind that special methods of agricultural melioration of soils (irrigation, drainage, liquidation of excess acidity, soil salinization control, anti-erosion and soil protective measures, etc.) are used on a comparatively small proportion of all agricultural land. At the same time, the main areas of agricultural land are used in practice without expensive methods of melioration. However, this does not mean that farmers do not constantly use many agrotechnical methods of soil and land improvement. They are undoubtedly concerned with systems of soil processing adapted to landscapes, crop rotation, rational systems to optimize agrolandscape elements, scientifically proven systems of fertilizer application, ways to protect plants from harmful organisms, methods of rehabilitating polluted soils, and many other techniques.

These and other as-yet undiscovered methods of soil processing appear to be the basis on which humankind can preserve the beauty and the delights of nature and ensure a worthwhile life in complete harmony with the laws of ecology and biology for every

one of the earth's inhabitants.

1. Agroeconomic Evaluation of Landscapes and Soils

Historically, landscapes and soils were evaluated according to principles of agroeconomy. The ratios of landscape components and levels of soil fertility differ significantly, not only within particular zones, but also according to differences in even a single soil characteristic. Research has shown that even within the limits of one farm with an area of not more than 10 km^2, dozens of various types of soils can be found. It is often convenient to compare one with another on an economic basis.

During recent years, the development of precision agriculture has brought to the fore the necessity to take account of soil types, bearing in mind their relief elements and, inside each field, the heterogeneity of soil fertility.

The scientific substantiation of precision, differential agriculture will be a new step on the path to agricultural optimization, and will make agriculture essentially more ecologically friendly, and economically much more efficient.

2. Organization of Agricultural Crop Cultivation

From the landscape agriculture point of view, the cultivation of crops in each soil-climatic zone, region, and farm should be strictly adapted to the landscape, its elements, and the level of soil fertility. The main purpose of agriculture is to produce the quantity and quality of food that can meet humanity's requirements. Agriculture should be highly productive, stable, and ecologically and economically expedient. Cultivation of any crop should be carried out in conformity with the general soil-climatic conditions of each region or area, and should be determined by these conditions.

Agricultural practice proves that rational cultivation of any crop cannot take place if soil-climatic conditions are not biologically suited to the crop. The level of production of any crop is defined by complexes of concrete factors that must be taken into account, and the level of efficiency of crop production is determined by the cumulative action and interaction of these factors. Taking the basic laws of agriculture as a guideline, it is possible to organize agriculture in each particular case in a way that is rational, highly efficient, and ecologically expedient.

The point is that one should not imagine that it is possible to cultivate any crop anywhere very efficiently without taking into account the condition of the field. We frequently observe how hopes of achieving high yields by increased use of fertilizers, lime, and irrigation do not come to fruition; the return on costs incurred seems low, and the operation sometimes simply ruins the farm.

Before deciding to cultivate a certain crop, it is necessary to test the soil: its degree of cultivation, level of degradation, climatic resources, and so on. It should not be assumed that soil can be improved immediately. As a rule, it represents a quite lengthy process requiring large investments and feedback (which may limit the speed of progress). At the very least, one must accept the scale of the task involved in measures for optimization of surface and groundwater resource use and the factors involved: regulation of soil physical properties, conditions of soil organic substance, normalization of soil solution acidity, maintenance of phosphoric and potassic soil conditions, level of natural and anthropogenous pollution with harmful substances, development of erosive processes, district relief, its inclination, and its geographical situation. Only by taking into account these and many other factors is it possible to organize rational agriculture in each particular case.

3. Optimization of Crop Rotation Systems on Agricultural Landscapes

Optimum use of fertilizers and pesticides, application of immunological, nonpersistent kinds of materials, along with biopreparations and other means of plants protection, and preparations of nitrogen biofixation can weaken the valuable role of crop alternation in maintaining supplies of nutrients to plants, and in weed and pathogen control. Fertilizers and pesticides make possible the repeated cultivation of a crop in the same field, and the opportunity for more relief specialization in crop rotation. They fundamentally change the criteria for determining the level of crop rotation with grain or crops requiring tilling between rows, forage, or specialized technical crops. Under intensive crop rotation the amount of applied organic and mineral fertilizers, chemical meliorants, and pesticides increases. The essential importance is in the restriction of crop rotation load by fertilizers and pesticides. The criteria for crop rotation, and the role of various factors, should essentially vary depending on the intensity of agriculture. In particular, the role of perennial grasses in the field and forage crop rotation should be reconsidered.

4. Optimum Ratio Between Landscape Elements (Plowland, Meadow, Forest, Reservoir)

The optimum ratio between landscape elements is not always maintained. In Russia in the central regions of the chernozem zone, the part of the country with the highest population and the richest chernozems, the extent of plowing has reached an extremely high level. It has taken place in spite of the fact that the relief of this zone is cut with ravines. Due to centuries of plowing, the chernozems have lost a significant part of their natural, potential fertility. And this is not all. Because of the dismembered character of the relief in this region, there is a very high rate of water erosion.

The extensive plowing has led to a reduction of forest areas and natural meadow land, and the unsatisfactory water regime has resulted in a decrease of the smooth/unruffled surface of the water. Today it is necessary to develop special measures and systems of land tenure in this region to correct the anomalies that have been allowed to occur. The optimal balance between landscape elements should be maintained so that the natural processes of substance and energy transformation are not catastrophically changed.

Humanity and civilization are exerting an ever-greater effect on nature. This should not be allowed to disrupt the biogeochemical flows of elements in agrosystems to an extent that initiates uncontrolled processes. The essence of this problem is to find ways of conducting economic activity on the land that achieve as far as possible the double (but probably completely unattainable) goal of, on the one hand, increasing food production to satisfy humanity's growing requirements for foodstuff and, on the other hand, a maximum protection of virgin nature due to minimalization of the use of resources.

There is a great debate throughout the modern world about the problem of trying to establish reasonable limits on the intensification of agriculture; this debate is often marred by wishful thinking. There are often attempts to establish various types of biological, organic, and frequently primitive, agriculture, often with a low productivity that is not capable of preserving nature and, at the same time, feeding humanity.

5. Agroecological Principles and Methods of Soil Processing

The intensification of agriculture, with the associated and ever-increasing application of mineral fertilizers, chemical meliorants, and pesticides, has changed the balance of mechanical energy expenses used for soil tilling. It became possible not only as a result of minimalization of soil processing, but "zero" methods of soil processing as well. Necessary tools were developed, they helped in many regions of the world. For example, nonmould-boarding plowing allows the change in soil processing from mould-boarding to surface tilling.

This measure helped to retard the growth of erosion and to prevent an increase in soil density. It was made possible by the availability of nitric fertilizers and herbicides. The widespread use of mulching systems of soil tilling, leaving plant residues on the soil surface on the field, provides opportunities not only for radical control for soil erosion, but also for the enrichment of the soil with fresh organic substances.

The general tendencies in the development of soil tilling systems have to be adjusted individually in each particular case of crop rotation, depending on the biological characteristics of crops, the phytosanitary soil condition, its level of fertility, and fertilization.

The phytosanitary condition of agrocenosis plays a role here. Not only can the level of soil contamination essentially grow under the minimum press on the soil under treatment, but also the development of diseases can undergo essential changes. The soil tilling system should take into account various natural and production factors.

6. Management of Organic Substance Contents in Soil; Regulation of Microbiological Processes

Management of the regime of organic substance contents in soil must be based on an awareness that this regime plays an absolutely essential role in increasing soil fertility, providing soil microflora and plants with energy, decreasing the negative consequences of chemical pollution of soils with heavy metals, radionuclides, pesticides, and other toxic substances, and increasing the ability of agriculture to remain stable under stressful conditions. The transformation from natural cenosis to agrocenosis inevitably causes a great decrease in the vegetative residue in the soil. The plowing of virgin soils is inevitably accompanied by a loss of humus content. As a result, the humic soil condition stabilizes at a different level, which is determined by the agricultural system and develops in various soil zones in different ways. In many cases intensive soil tilling not only provides "combustion" of organic substances, but also promotes the development of erosion, causing losses of humus on a significant level.

One of the main factors in fulfilling the goals we outlined earlier is the development of methods that will ensure an adequate humus balance. However, these methods should be based not upon the wishes of individual scientists merely to create a sufficient balance of humus in our soils, but also upon ensuring its long-term stability.

Here the old view on the direct connection between the productivity of crops and the content of humus in soil is still the guide. However, this connection is not absolute, and it is probably impossible to provide a good humus balance always, everywhere, at any price. In many cases where there is optimum application of fertilizer, the harvest level is largely independent of the content of humus. It is necessary to determine optimum, critical, and equilibrium levels for the amount of organic substances in soil, to establish its true role in the life of the soil and in its efficiency.

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Biographical Sketch

Vadim F. Ladonin was born on 9 July 1930 in Yaroslavsky region, USSR. In 1947 he graduated from agricultural college and in 1954 – from Yaroslavl Agricultural Institute, General Agronomy Department. After this for a short time he worked as agronomist in the collective farm. And in 1958 he graduated after Post-graduate studying in the All-Union Research Institute of Fertilizers and Soil Science (Moscow). In 1959 he got his Phd (Agrochemistry and Agricultural Sciences). January–September 1965 he worked as exchange student in the Department of Botany, University of Gvelph (Ontario, Canada) under supervision of Prof. Claiton Switzer in the field of biochemical aspects of carbamat pesticides action on the weeds and cultivated plants.

In 1976 he got a degree of Doctor of Biological Science in the field of plant protection and phytopatology. In 1958-1977 he worked for the All-Union Research Institute of Fertilizers and Soil Science (Moscow) as senior researcher, Head of laboratory and Deputy Director. Between 1977 and 1982 he worked for the International Atomic Energy Agency (Vienna, Austria) as an expert. In 1984 he was made a Professor and in 1993 he was elected as a correspondent member of the Russian Academy of Agricultural Sciences and in 1998, as a Academician of this Academy.

Currently (1982–), he is working for the All-Union Research Institute of Fertilizers and Soil Science (Moscow) as Head of laboratory and Deputy Director.

He is an author of more then 200 scientific publications in the field of agronomy, agrochemistry, plant protection, physiology and biochemistry of plants.

He was a member of European Weed Research Society and International Center of Mineral Fertilizers.