SOIL IMPROVEMENT

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Summary

Land reserves suitable for farming are very limited and, in many regions, are almost non-existent. The future of agriculture and food supply will depend on the efficiency of land management and the level of crop productivity.

There are several options that may allow us to increase this level. The first is the application of chemicals, including fertilizers and soil amendments. Growth-stimulating chemicals will be added together with seeds. Second is an improvement of soil tillage and crop rotation systems. The use of synthetic materials, including mulching materials and polyethylene films, will be extended. Synthetic films covering the soil surface allow us to control weeds and to improve the water and temperature regimes of soils. Their application makes it possible to minimize soil tillage, which reduces energy and material costs considerably; zero tillage technologies ensure the development of crops in almost natural conditions. Third, a wider use of automation is expected. In future, control of agricultural machines will be fully automated. Remote-control systems, including telemechanical systems, together with GIS technologies will make all tillage operations very precise and independent of weather conditions. A fourth factor will be

the improvement of agricultural machines. They will perform several operations at once, minimizing the number of passages and hence the load on the soil surface.

To prevent the development of negative degradation processes, a system of soil–environmental monitoring will be organized. In particular, the monitoring of water regimes on drained land and in adjacent territories will include observations of the groundwater level, chemical composition of surface, soil, and subsoil waters, water discharge from drains, and so on. Remote-sensing methods will be widely applied for this purpose. Continuous soil-environmental monitoring will reveal the development of negative processes (bogging, salinization, compaction, erosion, etc.) at an early stage so that the necessary control measures can be taken. Potentially vulnerable lands will be gradually excluded from agriculture. For sustainable development in conditions of limited soil resources, it is essential to give priority to soil conservation policy.

1. Introduction

The improvement of arable lands aims to create a level of soil fertility that can provide maximum crop yields of high quality at low cost without significant deterioration of the environment.

There are several methods of land improvement, including agrotechnical work, biological amelioration (by growing soil-amending crops), chemical amelioration (fertilization, liming, weed and pest control, etc.), and physical amelioration (the creation of optimal physical conditions in the plow layer via application of appropriate tillage methods and special regulation of the water, air, and temperature regimes of soils). The best results can be gained by the combined application of several methods.

Positive changes in the soil fertility status manifest themselves through:

- an increase in the depth of the humus layer and better humus quality,
- improvement of soil structure and, hence, of the water and air regimes of soils,
- increase in the contents of total and available nitrogen, available phosphorus, potassium, calcium, magnesium, and microelements,
- optimization of pH conditions,
- enhancement of biological soil activity,
- earlier warming of the upper soil layer after the winter period,
- increase in the infiltration capacity that minimizes the risk of erosion,
- lower rates of crop disease and weeding, and
- improvement of sanitary conditions.

The changes taking place in soils under the impact of ameliorative procedures may be very considerable. Often, the properties of ameliorated soils differ significantly from the properties of the original soils. It is important that these changes occur relatively quickly. Thus, we can say that soil evolution in conditions of ameliorative agriculture proceeds much faster than the slow evolution rate of virgin soils.

This article considers chiefly the problems of soil improvement in countries with temperate humid climates. The description of particular methods of soil improvement is based on experience gained in the countries of the former Soviet Union (Russia, Belarus, Ukraine, etc.), the United States, Canada, and China. However, methods of soil improvement are not essentially different in countries with tropical climates. In all regions, we have to prepare the soil for farming (by planing the soil surface and removing stones and woody vegetation), improve the soil yielding capacity (by adding soil amendments, conditioners, and fertilizers), and control negative processes that can not only decrease crop yields but also destroy the soils themselves. These requirements have a universal character.

2. Kinds and Technologies of Agrotechnical Work

Agrotechnical operations encompass a series of measures aimed at clearing the soil surface of wood, shrubs, and stones so as to improve the properties of soils for agricultural production. Along with the removal of woody vegetation, shrubs, stumps, tussocks, thick moss cover, and stones, agrotechnical measures include land planing: filling hollows and rills and leveling small mounds, as well as primary soil tillage.

These operations are especially necessary when dealing with waterlogged lands subjected to artificial drainage. Without them, the productivity of artificially drained rangelands may decrease because the new water regime of the soils may be unsuitable for existing plant species.

Agrotechnical reclamation should be preceded by special topographic, soil, and geobotanic surveys of the territory to be reclaimed so that technological maps of the area can be compiled. These maps should contain information about the species composition and productivity of vegetation, and about reclamation conditions.

In particular, they show areas of woody vegetation and indicate the difficulties that might be encountered during its removal; the kind of soil, its bulk density, and the depth of sod layer; areas of peatlands with buried timber; areas with stumps and stones; areas that require land planing; and so on.

These maps are used as the basis for recommending optimum strategies of reclamation in different parts of the territory and determining the cost of reclamation. The suitability of the territory for particular kinds of machines is assessed.

Finally, the areas of soils that should be left in the natural state because of their unsuitability for agriculture and/or because of their environmental significance (specially preserved territories) are delineated.

This is followed by the elaboration of a specific plan for reclamation procedures, detailing the kinds and schedule of reclamation works, the cost, and the equipment required.

Reclamation procedures should not affect areas used for recreation, hunting, fishing, and ritual ceremonies by local people. Any design of a future cultural landscape should take into account not only economic considerations, but also the aesthetic functions of the environment.

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Bibliography

Abdark H., Bohne K., and Bonan U. (1986). *Landwirtschaftliche Meliorationen,* 316 pp.. Berlin. [A textbook on land reclamation for agricultural colleges.]

Brush Management and Range Improvement Research (1980–1981). (1982).College Station, TX. [A study of brush management practices and their efficiency.]

Larson J. E. (1980). Revegetation Equipment. Catalog Prepared for the Vegetation Rehabilitation and Equipment Workshop. Washington: US Govt. Printing Office. [A catalog of machines used for rehabilitation of wastelands]

Starikov Kh.N. *Soil Amelioration and Farming*. (1968). Moscow: Rosagropromizdat (In Russian). [The main kinds of soil amelioration are described.]

Troeh F.R., Habbs J.A., and Donahue R.L. (eds.). (1980). *Soil and Water Conservation for Productivity and Environmental Protection*, 763 pp. J. Wiley. [The problems of soil conservation are discussed.]

Biographical Sketch

Khristophor Nikolaevich Starikov graduated from the Timiryazev Agricultural Academy (Moscow) with a degree as a specialist in Agroforest Amelioration. He is a Doctor of Technical Sciences, and serves as Professor of the Department of Soil Science and Soil Reclamation of the Nizhni Novgorod Agricultural Academy (Nizhni Novgorod, Russia). Professor Starikov works in the area of cultivating and biological reclamation and the design of complex drainage–irrigation systems. He is the author of several monographs devoted to these problems.