


# Chapter 5

## Traditional and Innovative Technologies for Monitoring Soil Fertility

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### ABSTRACT

*The article provides an analytical review of traditional and innovative technologies for monitoring soil fertility in Russia and abroad. The main development trends, new methods and tools for collecting, analyzing and interpreting information have been identified. The role of artificial intelligence, nanotechnology, GIS technologies, mathematical modeling, remote sensing of the Earth, physical testing for integrated assessment of soil pollution, etc. is shown. Examples of the use of the latest developments in precision agriculture, smart agriculture, unmanned aerial vehicles and robots for the purposes of agrochemistry and soil science are given. The chapter uses information from scientific and methodological sources of literature, as well as patents for inventions.*

### INTRODUCTION

Ensuring food and environmental security for the population of any country is possible only under the condition of sustainable development of the agro-industrial complex. In many respects, it is determined by the state of soil fertility, which has not only ecological, but also economic and social significance. As shown by world and domestic experience, maintaining and increasing soil fertility when used in production is possible only if a set of scientifically substantiated factors is taken into account.

To monitor changes in soil fertility, identify the dynamics of the agrochemical composition and take timely effective measures, up-to-date data are needed. For this purpose, periodically repeated agrochemical and soil surveys of agricultural lands, i.e. their monitoring, are carried out in Russia. It ensures control, rational use and protection of agricultural lands based on an assessment of their condition using uniform

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unified methods. Based on its results, recommended agrotechnical, agrochemical, phytosanitary, anti-erosion, melioration and other measures are planned and carried out.

Monitoring of agricultural lands is developing in accordance with new scientific knowledge and the needs of society. While maintaining basic traditional approaches, it is supplemented by innovative technologies.

The purpose of the study is to analyze the main directions of development of innovative technologies for monitoring agricultural lands as a supplement to traditionally used ones.

During the perestroika carried out in the 90s in Russia and the resulting financial restrictions, the volumes of use of fertilizers and ameliorants were significantly reduced, and a tendency towards a decrease in the soil fertility of agricultural lands emerged. The growth in the volume of agro-industrial production led to an increase in crop yields, but often to an imbalance of nutrients in the soils and, without compensation, to their depletion. In natural biogeocenoses, a relatively closed cycle of macro- and microelements functions; in agrocenoses, which include fields, gardens, etc., nutrients are alienated with the harvest, which leads to a break in the cycle. Fertility indicators decrease. The availability of nutrients to plants worsens. They are lost as a result of runoff, erosion, and soil acidification.

This increases *the relevance* of agrochemical and soil survey data on agricultural lands and obtaining accurate information on the condition and composition of soils and their dynamics, as well as patterns of their spatial and temporal distribution on the territory; allows optimizing the selection and application of soil cultivation and fertilization systems taking into account economic and environmental factors; calculating the application rates of ameliorants and mineral fertilizers for specified crop yields and product quality; regulating agrochemical, agrophysical and biological parameters of the soil, especially pH, humus balance, macro- and microelements; e) identifying trends in their change and, accordingly, developing prognostic models to prevent and eliminate the consequences of negative processes, etc.

Agricultural lands are monitored by specialized state institutions such as the centers and stations of the State Agrochemical Service of the Ministry of Agriculture of the Russian Federation. Periodically, once every five years, they conduct agroecological monitoring of lands, and over 60 years of work in a number of regions of Russia, more than ten rounds of agrochemical soil surveys have been conducted. The monitoring of soil fertility of agricultural lands conducted by the State Service requires further improvement, primarily in terms of the list of indicators. The main objective of monitoring the fertility of agricultural lands is to observe the chemical, physicochemical, biological, physical and water-physical properties of soils, their pollution by production and consumption waste, chemical and radioactive substances, as well as the phytosanitary condition of soils and crops, meteorological conditions and plant productivity on each land plot.

An important point is the use of unified methods regulated by state standards in agrochemical survey. All centers and stations use the “Guidelines for conducting comprehensive monitoring of soil fertility of agricultural lands” (2003). A unified methodological approach allows for the correct comparison of data obtained by different stations (centers), as well as data from the same sites in different years.

Soil samples are collected from elementary sites with an area of five to twenty hectares, depending on the region, according to the state standard “GOST 28168-89 Soils. Sampling”; preparation - in accordance with “GOST 17.4.4.02-2017 Interstate standard. Nature protection. Soils”.

A soil probe is used to collect soil samples on dry and dusty soils, and a soil drill is used on stony or frozen soils. Hydraulic or mechanical samplers are also used to take surface and deep samples. Agrochemical, agrophysical, biological and ecological parameters are determined in soil samples (Tables 1 – 2) .

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