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RESEARCH ARTICLE

Modern Tools and Methods for Operational Measurement of Soil Humidity in Agricultural Production to Obtain Environmentally Friendly Products in Azerbaijan

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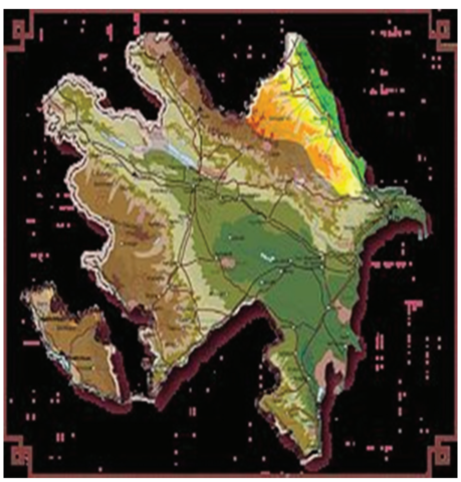
ABSTRACT

Current information about soil moisture and temperature in the agricultural production management system is necessary, first of all, for making operational decisions when developing an environmentally friendly irrigation technology for growing crops to obtain the maximum yield.

Key words: Aerospace methods, Arable land, Calibration, COA, Drill, Ecology, Moisture test, Moisture, Soil, Tool, Water moisture

INTRODUCTION



The steady growth of the population in the republic sets tasks that ensure their provision, including agricultural products. It is known that in Azerbaijan, starting from the 50s of the past century, irrigation and reclamation construction have been carried out on a large scale, which has gained a large scale in the 70s. From year to year, the pace of construction of the water sector increased.

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The result is as follows:

- irrigated area increased from 1200 thousand ha to 1400 thousand ha
- Total water intake increased by 9.8 million cubic meters. m^3
- The area covered by the collector-drainage network up to 400 thousand square meters; ha; (opening of the collector-drainage network-273.0; closing-115.0 thousand ha; and vertical drainage up to 5 thousand ha).

The productivity of agricultural crops has noticeably increased, for example, stalemate has reached 30,8 centners per hectare; corn-24,7 c/ha and vegetables-204 c/ha. Along with the successes achieved in water management construction, the following land reclamation measures should be carried out in the future:

- Reconstruction of the irrigation network in a separate region of the republic;
- Improvement of reclamation state of lands:
- Increasing the water supply of agricultural crops;
- Land planning;
- Construction of small pools;
- Development and wide introduction of systems of low-intensity water protection technologies and crop irrigation technologies;

- Development (for the needs of agricultural production) of additional areas, through the introduction of arable-irrigated farms;
- Implementation of mechanization and automation of the process of irrigation of agricultural crops, etc.
- The use of progressive methods and technical means for studying the state of the soil and methods for express measurements of agroreclamation parameters, etc., (including aerospace measurements).
- Introduction of advanced technologies for the production of an environmentally friendly product and increased productivity.

It should be noted that the effectiveness of the use of advanced water protection irrigation technologies and its further development in the republic is to develop and introduce into production the latest achievements of domestic and foreign science, technology, and best practices to ensure high production rates and increase their profitability, all measures raising labor productivity, raising the level of agricultural culture, making the best use of production assets, improving the quality of labor irrigation, and increasing the reliability of the technology used. Inconnection with the pollution of the environment by cultivation techniques, the problem of obtaining environmentally friendly agricultural products arises.

This requires complete information on the state of soils, on their fertility, on the intensity of soil pollution with chemical elements, pesticides, radionuclides, etc., and also on the dependence of this pollution on hydrometeorological conditions. Earth like main natural object of study is the production reserve.

Soil moisture and temperature are one of the main physical characteristics of the soil that determines its fertility.

Without the presence in the soil of the necessary (required) amount of water and the appropriate temperature, agricultural crops do not sprout at all.

Soil moisture affects the solubility, displacement and effectiveness of organic and mineral fertilizers, the degree of contamination of the soil with pesticides and other products, the origin of products, and the extent to which agricultural plants are harmful to human health. Chemists.

Current information about soil moisture and temperature in the agricultural production management system is necessary, first of all, for making operational decisions when developing an environmentally friendly irrigation technology for growing crops to obtain the maximum yield.

This refers to technological solutions (for example, agricultural techniques) in matters of basic and pre-sowing tillage, the feasibility and timing of sowing crops, forms and periods of irrigation and application of mineral fertilizers, etc. However, the authorities, science, and production have far from complete operational information on soil moisture due to the lack of the necessary methods and technical means for obtaining them in the country's agricultural industries.

In addition, information on soil moisture and temperature could be most accurately and quickly obtained using an artificial satellite, but this information is limited only to the surface of the earth or a few centimeters of the topsoil. Here and later, the data obtained from space, necessary for identification. Moreover, this means the need to produce sensors for an artificial earth satellite. To realize this, it is necessary to have reliable ground-based express methods and technical means for obtaining information on soil moisture and temperature. Such installation methods should provide information in a deep excavation (although at a depth of the underlying root system of plants) and the area of agricultural fields.

The most well-known method for obtaining data on soil moisture from its surface to a depth of 100–150 cm, with a layer every 10 cm, is the thermostatic-weight (TV) method. It provides the ability to obtain data on soil moisture to the entire depth of the underlying plant bark, which makes it inviolable using aerospace methods when it comes to objective information in what is determined by point agricultural fields.

However, if we are talking about the relative surface moistening of the entire field, then here the TV method, such as any other ground-based method, cannot compete with aerospace methods and the ease of obtaining this information.

At the same time, the TW method has a number of disadvantages that do not allow it to be used as a standard in the production of ground and aerospace instruments.

In addition, the spread of measurement time for soil moisture is 1.5–2 days.

This leads to a delay in making important technological decisions, with significant settings, because. Or dry wind, and soil moisture during this time, the image can change significantly. Although, for its improvement, development and implementation of high-speed express devices, many studies were organized to measure soil moisture.

However, the devices proposed so far (including the VNP-1 neutron moisture meter, the Agrotester, the SVP-5 high-frequency soil moisture meter, and the VSG-1 soil parameter meter) are not widely used due to the following reasons: objective reasons. For example: the use of VPN-1 requires the installation of plants on the floor around pipes (metal or plastic) that prevent the middle row from processing arable crops.

High-frequency moisture meters SVCh-5 are not able to completely replace the TW-method, since a soil sample, a soil board is used for sampling. The most adapted to the conditions of use in agriculture “Agrotester” and HSV-1. Both devices have a remote touch panel, to which the measuring unit is connected, but after the measurements, the sensor and counter are removed from the field.

“Agrotester” does not carry out field tests, does not check measurement inaccuracies due to measurement inaccuracies, which are based on the method of measuring the complex soil resistance in an alternating electric field (the so-called conductometer method). At the same time, the sensors of the device are made in that they serve as two round spiral blades and as a means of immersing the sensor to a given depth and as a measuring means – a condenser, in which the medium between the cover-vane is polished. However, the VPG-1 device shows a relatively acceptable trace result and is recommended for implementation at hydrometeorological stations of the CIS countries back in the 80s and 90s.

However, for other reasons, it also did not find wide distribution. To determine the soil moisture according to the readings of HSV-1, a rather complicated technique is used. To indicate the readings of the device, a micrometer is used – the device itself is inaccurate, easily damaged in the field.

For the wide application of VPG-1, it was necessary to significantly strengthen the design of the sensor, simplify the calibration and measurement methods, and use a more reliable and accurate digital indication of instrument readings in the measuring unit.

To eliminate this defect in 2001, this design was finalized on VPG-4S, which surpassed the TU-method in all respects, in terms of power and accuracy of soil moisture data on a separate agricultural field (land). The standard deviation in this case from the specified thermostat-mass of the method for HSV-4C was 1.5%. This is 0.5% more accurate than VNP-1 and 1.0% more accurate than HSV-1.

However, this can be achieved due to the fact that the analysis of these studies indicates the absence of a common opinion (proposals) regarding the principle of constructing automated measuring systems not only in agro meteorology but also in hydrometeorology in general.

The most suitable for methods and means of automatic control of hydro reclamation parameters, in our opinion, is the finishing company “Vaysal,” which offers the consumer a certain automatic system for monitoring the state of many elements of the weather based on specialized (meteorological) computers, which is widely used in Azerbaijan. However, some scientists have proven that the Vaysal system is “locked,” that is, it cannot be used without special weather computer sensors of the company.

In addition, to solve such problems, UKRNIGMI developed an automatic system for monitoring soil parameters, which, in many ways, surpass the similar development of Vaysal.

Since the proposed system UKRNIGMI is compatible with any sensor and can be directly connected to computer network via standard connection without additional connector.

The system will allow simultaneously capturing and transmitting data from a large number of sensors over a distance of up to 10 km through cable and up to 100 km or more using the object’s radio system. In addition to calibrating the sensor parameters, preliminary entering into the PC memory for permanent storage and deletion of data from 200 to 300 sensors in 1 second is provided, rather than entering them before measuring with each individual sensor, which is offered by the Vaysal company.

The author’s proposal for the complete set of an automated agro meteorological point sensor and measuring device (own production) with the following parameters:

- Air humidity (range 25–100%, at temperature from −4 to +50°C)
- Soil moisture (range 4–40%, at temperatures from 0 to +50°C)
- Air temperature (range from −50 to + 50°C);
- Soil temperature (range from −25 to +50°C);
- Photosynthesis to active PAR radiation (range 0.30–0.70 mm), etc.

According to the developer's description, these sensors and "signal-to-voltage" functional converters are universal, that is, suitable for use both in an automated measuring system and in a separate discrete device.

In addition to the soil moisture and temperature sensor, the temperature, and air humidity sensor, the sensor of the automated agro meteorological station FAR (AAP-1) includes a multi-channel analog-to-digital converter combined with a PC on a cable or through a radio channel. The computer provides processing and storage of agro meteorological information.

The AAP-1 base is completed with 16 sensors.

The AAP-1 kit included soil moisture sensors at depths of 10, 20, 30, and 50 cm (5 pcs.), soil temperature sensors at depths of 10, 20, 30, and 50 cm (5 pcs.).), air humidity sensors (2 pcs.), air temperature sensors (2 pcs.), and sensors for measuring total and photosynthetic active solar radiation (PAR) – 2 pcs.

Depending on the consumer's request, the number of channels can be increased to 64 or more to connect any quantity sensor.

This will not interfere with the work of the AARP, because its speed allows you to "interrogate" up to 200–300 sensors for a duration of 1 s.

Along with the above methods, there are also aerospace methods for determining soil moisture and temperature.

Based on the results of our analysis of the patent and scientific literature on the aerospace method for monitoring the state of the earth's surfaces, in particular vegetation and soil, it becomes firmly established that little attention is paid to the verification tool when developing methods for such monitoring by the ground method.

Models developed in this direction for assessing the state of remoteness of plants and land from satellite data, which are based mainly on the laws of optometry, thermodynamics, and other physical laws, will always require experimental verification underground conditions. The authors argue that this requires a reliable ground-based network for monitoring the state of plants and land.

However, this raises very complex and at the same time large-scale problems associated with the peculiarities of aerospace and ground-based methods. The first feature is that the separation capacity (coverage area) of an aerospace sensor object and a ground object differ greatly. Hence, if the sensors of the accompanying earth cover the earth's surface area, which has the shape of a stake with a diameter of a group of tens of meters to several kilometers, then thermostats – the weight method can characterize a clod of earth with a diameter of up to 3–4 cm. At the same time, HSV-4 sensors can operate in a stake-shaped field with a diameter of 60 cm or more.

Based on the fact that if for a space sensor for a separate ability to take a circle with a diameter of 10 hectares, then the sample volume for the humidity of the earth's surface for the companion sensor will be 7.85 * 107 cm^2, for HSV-4C - 2.826 * 103 cm^2, and for TW -method – only 7.1 cm^2.

So far, there is one striking way to take into account this feature, this feature in the area of the number of repetitions of measurements with the VPG-4S device and, especially, determining soil moisture using the TW method. On the other hand, with the help of aerospace methods, it is impossible to obtain a separation of temperature and soil moisture to a depth of 1–1.5 m.

Change ground-based means of receiving information about soil moisture and temperature.

The second feature is that aerospace data, as a rule, do not coincide with ground data in time and space. It is known that the paths of satellites often do not correspond to the location of the existing network of hydrometeorological stations and points that conduct ground-based observations of the state of the atmosphere, plants, and soil.

The terms of agrometeorological observations also, the whole bowl, do not correspond to the time of the passage of an artificial satellite through location stations and points. This feature can be taken into account in two ways:

1. With a well-studied microclimate to the characteristics of the territory, the daily course

of agrometeorological factors, it is necessary to make appropriate corrections to the data of ground-based observations.

2. On the route of the artificial satellite, to place in advance mobile agrometeorological stations with an increased frequency than at the hydrometeorological station, the observation period. Such points allow not only to more accurately link ground observations to aerospace data, but can also serve as a new, very effective technical base for studying the microclimate of a territory.

The third feature: Different physical principles are spelled out in the basic ground and aerospace measuring instruments. In aerospace methods and measuring instruments, several methods are used to measure parameters laid below the surface of the earth.

This registration reflected radiation in the visible part of the spectrum, in the infrared (IR) range and in the radio frequency range, and also recorded natural gamma radiation on the surface of the earth. The VPG-4S instrument uses a measuring method for measuring soil capacitance in alternating electric current. The TW method is based on weight drying and determination of the amount of evaporated water. Each of the above three methods has its own advantages and disadvantages. The advantage of aerospace methods is that they are fast and cover a large area.

However, they also have a disadvantage in that they cannot be used to achieve the distribution of agrometeorological factors at a depth of up to 1–1.5 m, which is an advantage of land structures. The VPG-4S device has the superiority over the TV method, which characterizes a soil sample with a volume of 28 L, and the TV method – only 22 ml.

The TV method, with the exception of the disadvantage mentioned above, has the main advantage over HSV-4C and aerospace methods.

Its advantage is that it guides the method and maintains the gradation of means, both soil moisture meters and aerospace soil moisture meters. However, an attempt to calibrate space sensors only by the TV method may be unsuccessful, unless the VPG-4S is used as an intermediate setup.

Thus, such a correlation is necessary when using all possible methods that allow obtaining the most objective information on soil moisture.

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