УДК 631.432

Problem of deficiency of water on plowlands of Ukraine

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The purpose. To generalize the existing information, as well as focus on the real and urgent problem of augmentation of deficiency of the water necessary for provision of sowings of crops during their vegetation in conditions of bogharic agriculture. **Methods.** Comparisons, analysis and generalizations of versatile scientific information. **Results.** Modern agrarian production needs results of scientific researches and recommendation which will help landowners to understand more widely correlation of cultivated plants in sowings with temperature, speed and force of a wind, indexes of relative humidity, presence of carbonic gas in sowings, intensity of processes of transpiration and photosynthesis, intelligent use of the limited stores of moisture in soil. **Conclusions.** Complex environment protection, augmentation of opportunities of the nature will resist to destructive influence of human activity to promote real decrease of stress level of water balance in regions and to security of necessary level of productivity of crops.

Key words: *climate, soil, water, wind, losses, relative humidity of air.*

https://doi.org/10.31073/agrovisnyk201806-09

One of the irreplaceable factors of life is water. Under conditions of sufficient moisture, scientists in their research and agrarian practices do not pay particular attention to the problems of accumulation, preservation and rational use of available moisture. Such an assertion is based on the sad fact that water issues in the national scientific publications of agrarian direction in recent years are clearly insufficient, which indicates the level of priority of such research topics in our country. A similar situation with research on ways to save water and its rational use on arable land and in scientific institutions of the National Academy of Sciences of Ukraine and agrarian universities.

How to explain this attitude to one of the irreplaceable factors of life? Perhaps the authors simply do not know that such topics are actively investigated by domestic scientists and have significant scientific results that have already been introduced in the agrarian production? People tend to be wrong, we may be mistaken. Sorry, there are no errors. The real life of the agrarian sector of the country's economy already requires concrete answers to the questions and problems that have become relevant and are rapidly gaining acuteness.

However, everything is in order. At meetings of authors with agrarians from different regions of the country, often there are acute practical questions: how to manage a profitable agrarian production in the absence of precipitation during 3-6 months of the warm period of the year? Where to get water for crops, especially priority late market crops: sunflower, soybean, corn during the formation of a crop? How to sow crop of rape, wheat, barley and winter rye under conditions when during the whole summer and third of autumn there were no rains?

We have tangible climate change. The sum of effective temperatures over the past 20 years in the country during the growing season has increased by an average of70-100^{0}C. For example, until 1989, the average annual temperature in Odessa was 10,70 °C, and in Kiev - 7,70 °C, then by 2007 it grew in Odessa to 12,50 °C, and in Kyiv to 10,60 °C [1, 2, 3]. The temperature regime of the capital almost equaled the amount of heat of the southern seaside city in the past.

Producers do not need an explanation like climate change, you do not do anything here. Necessary concrete ways that can provide the opportunity to successfully manage the entire agricultural complex in modern conditions. What, in such conditions, can offer agrarians? Answers must be given by science, that is, we are with you, regardless of departmental subordination of research institutions.

Let's try to look at the problem of water shortages in the fields from the point of view of not agrarian - practice, but a scientist. Why is a shortage of water on arable land?

The amount of precipitation in the main soil-climatic zones of the country in the last 30 years did not become less than the average multi-year indicators. Where is the real increase in water shortages in arable land?

The absorption of solar radiation from the sun to our planet also did not change significantly and is within the solar constant - 1.37 kW / h. The atmosphere of the planet, the angle of incidence of rays and the presence of clouds significantly affect the intensity of the radiation energy of the solar radiation reaching the arable land [4,5]. A similar situation occurred 30 years ago. What has changed fundamentally?

The traditional limit (to the north) of the zone of sufficient humidification was along the line: the south of the Kiev and Zhytomyr regions. In the last decade, the named areas are almost entirely in the zone of unstable moisture. The displacement of the delimitation line to the north is from 180 to 200 km or more. At the same time temperature fluctuations have risen. For example, the daily fluctuations of temperature in our time reach 10-150C, which leads to induction of temperature stress in crops of cultivated plants [6,7].

Why droughts in our fields have become 2-3 times more frequent than it was thirty years ago? Meteorologists and climatologists argue with figures that the heat in the regions over the period increased from 15 to 35%, especially in spring and autumn. So where is the extra heat taken, if the activity of the Sun almost did not change? There are also specific answers to such questions: the increase in the content of carbon dioxide (CO_2) in the atmosphere from 1900 to 2000 is more than 30% [8]. That is, the effect of "greenhouse effect" in the atmosphere is intensified.

However, the greenhouse effect can not explain all the unwanted phenomena encountered by modern farmers inNorthern lands. Let's give another example. Why in the second half of spring in the regions of the country often formed stable anticyclones with dry sunny weather, strong wind and the absence of such desirable rains? Let's try to sort out. Ukraine has all the countries of Europe having the worst supply of water. This is a sad objective fact. In a world per inhabitant of the planet it is necessary to have at least 5000 tons of water per year (in developed countries to 8000 tons). The level of consumption of fresh water from 1900years per person increased by 10 times [9, 10]. Such indicators also take into account the needs for water for irrigation crops. Our territory is far from the ocean and the air masses that carry moisture, mainly consume its reserves along the way to us in the territory of Western and Central Europe. The regions of our country often encounter such a damp air mass of the Atlantic Ocean's space is not very hospitable: anti-cyclones.

The formation of anticyclones over the country's spaces contributes to the specifics of the global circulation of air masses and our economic activity, primarily the high level of plowed land and the scant area of forest plantations, (with the chopped forest strips less than 16.6%). In our country 57% of the territory has been transformed into arable land. For comparison, in the USA -12%, in the EU countries an average of 25.6%. Forests (man-made) in the EU countries occupy more than 30% of their territory [11, 12]. Areas of arable land, in the spring of which there is still no well-developed cultivated vegetation with sufficient projective coverage of the surface of the fields, are converted into heat generators due to low albedo rates. Radiation energy is maximally absorbed by the surface of the earth and transformed into heat.

At present, the general laws governing the distribution of the flow of solar energy in the atmosphere of the planet are known to science. Briefly remind them.

In an atmosphere of loss (scattering and reflection again into space), the energy of the Sun reaches an average of 30%. About 70% of the stream of radiation goes to the surface of the planet. The intensity of energy flow is influenced by many factors: 20% of the amount entering the atmosphere

Reflecting again into the cloud space, 19% of this flow of cloud absorbs, 26% finds to the surface of the planet in the form of scattered in the atmosphere of radiation energy (this energy is not direct light, but light in the shadow), 25% of the energy of direct rays comes directly to the surface of the land or the ocean

However, this is the structure of radiative energy inflow. The question of its balance is important to us. Accordingly, the structure of energy consumption, including reflection (albedo), is also needed. The largest coefficient of reflection of the radiation energy is fresh snow, which, depending on the angle of incidence of rays, reaches from 75 to 95% of the value of the inflow [13,14].

The hardwood or mixed developed forest characteristic of our country, reflects from 10 to 20% and absorbs 80-90% of the radiation energy of the incoming Sun. In the territories that have been converted into arable land (in the presence of crops), the amount of absorption of the incident beam of radiation energy

increases by an average of 6-10% (reflection accordingly decreases, energy remains in the region) from the indicators of the energy balance of the forest [15, 16,]. It seems that the magnitude of the changes is small, but their effect in the balance of energy in the regions is very noticeable. An even greater share of the absorption of radiation energy is manifested by the surface of land without vegetation (steam fields), asphalt roads, aerodromes, roofs of buildings, etc., which are actually heat generators.

Such changes in the distribution and balance of the solar energy in the whole regions are sufficient to significantly increase the temperature of the air and atmospheric pressure. In the high pressure zone, rain clouds do not come, they are bypassing such a region.

Accordingly, the level of cultivation of a territory in a particular region significantly changes the energy balance of the regions. In order not to significantly violate it, the area's cultivation should not be more than 36-42%, of which, in the structure of crops, the proportion of broad-leaved crops should not exceed 30% [17]. Existing modern crop structure actually ignores agronomic knowledge, it is focused only on market whims. Such a pragmatic approach of agrarians to the main means of production - arable land has already led to the fact that more than 80% of the country's arable land has active erosion processes that need to be stopped urgently.

However, this is only part of the problem. During the year, our nature still sends down to our fields. The nature and time of their arrival has its regional peculiarities, which deserve a detailed detailed analysis of the soil-climatic zones.

Let us dwell briefly on the forest-steppe zone. According to many indicators over the year, the region receives an average of 500-550mm of water. Over the years the amount of precipitation varies traditionally within 20%. In abnormal years up to 50% of the annual amount of precipitation [18]. For many centuries, this soil-climatic zone was the most optimal for growing crops in most field crops. It combines rich chernozem soils with sufficient amount of heat and moisture. Modern farmers regularly suffer from a shortage of water during the growing season of crops, especially late crops: corn, soybeans, sunflower, and in recent years even wheat.

Let's try to do simple calculations. As a basis we will take the approximate number -500 mm of rainfall per year. What does 500 mm mean? This is 500 l / m2, or a layer of water in a field height of 50 cm, which collects for a calendar year. If you take for calculations the volume of water consumption of cultivated plants, taking into account transpiration coefficients of winter wheat plants, they are within 400-500. We will use in calculations 500 (maximum). It turns out that for the production of wheat crops, the winter wheat yield is 10 tons / ha (1 kg / m2) and the same amount of by-products (1kg / m2 straw, leaves and roots), total 2.0kg / m2 dry weight, the required amount of water which has assimilate plant plants in the course of their vegetation (taking into account transpiration processes) or 100l / m2 or 1000m3 / ha. (thousand tons / ha). That is, for the successful formation of a high crop of winter wheat, it is enough to digest plants of culture from the soil about 20% of the volume of water entering the arable land during the year (5000 t / ha). This is true in theory.

At the same time, in the real world, the situation with the provision of crops moisture develops differently. Even in the thoughtful and professionally well-prepared haggonomists of a number of farms in the Kyiv region during the growing season of 2017, winter crops were not really able to fully realize their productive potential due to the actual lack of moisture in the soil.

The situation does not fit into well-known agronomist laws. Traditionally, life proved that for a successful growing season and yield formation Kolosov winter crops in forest-steppe zone average long enough moisture reserves in the soil formed in a cold season.

The actual moisture content of the soil in the region at the beginning of the vegetation in the summer of 2017 was at the level of the average perennial. Even in the absence of new rainfall in the spring, they were supposed to provide winter crops for harvesting. However, this did not happen. A month before the harvest (the first decade of June) in the meter layer of soil in the farms of the Kiev region was an average of 36-43 mm. water, that is, there was a "dead stock" which is almost inaccessible to plants of culture.

The situation of providing crop moisture in 2017 is a typical example. The main volume of real moisture reserves that can provide a successful vegetation of plants (almost 80%), lose arable land.

Before the actual science and practice is a complex problem: how to accumulate as much as possible, keep andrational use water on agricultural land in the regions during the year, especially in the warm season?

Traditional farming, under the new conditions of moisture deficit, in fact, is not sufficiently effective. The fields lose the moisture that comes to them, and the crops are left without the need for a successful vegetation of water volumes.

Science is not in place. Active research in molecular biology and genetics, biotechnology and breeding are actively seeking promising initial formation and forms of plants to create varieties and hybrids with lower transpiratsiynyh ratios greater drought tolerance and ability to overcome dis-stress different nature.

However, all these achievements can not completely replace the irreplaceable factor: the availability of water available to plants in the soil. Therefore, it is expedient to significantly intensify scientific research on the issues of accumulation, conservation and rational use of water by crops of cultivated plants, taking into account the specifics of the regions.

Improvement and expansion of irrigation systems is promising, but this method of farming has its own objective limitations and can never be applied to most areas of arable land in the country. There is no rational alternative to bequeathed agriculture. We have to perfect it and adapt it to the new realities of life.

First of all, for arable land, especially the zone of the Steppe and Forest-steppe, a system of measures is needed that would allow precipitation not to leave the boundaries of the fields. Rain or snow must come vertically to the ground, rather than coincide with streams on the surface of the lowered places and to carry out unwanted processes of water erosion of the arable layer.

Even if the water is directed to the arable horizon of the soil, it must still be kept in the layer where the roots of the plants are located. As you know, moist soil colloids and humus particles are best kept. The chronic deficiency in recent decades of organic carbon (C) in the arable soil layer, primarily in the steppe zone, is the main cause of the loss of the arable layer in the fields of its valuable agronomic qualities: optimal structure, acceptable density, water and air permeability, stock of organogenic compounds and the ability to retain moisture [19].

Farmers' pragmatists today ignore the importance of these factors, but the realities of life will stimulate them to listen to the advice of science. Trends in the complications of growing crop conditions raise the question: either civilized work on the ground according to scientific recommendations and have a stable profit, or we stop farming in the agrarian sector due to the actual shortage of water and the inability to harvest.

Statements that, in the absence of animal husbandry, agricultural producers are deprived of organic fertilizers can not be taken as an argument. This is just a formal refusal to deal with organic fertilizers. People today have no desire to work with them.

Where to get organic fertilizers for arable land? On such a question, is it appropriate to answer the question? Manure and animal waste in its main part consist of what substances? The answer is unequivocal - from the fodder crops that grew up in the fields.

No one forbids making the organic mass of the field and the field shorter if there is no farm. Return the cultivated organic mass to arable lands. In this case, you will not have commercial products of livestock, but there will be a positive effect of organic substances on arable land and, accordingly, an additional crop yield. Of course, this is a conscious exclusion of a certain percentage of arable land for the production of commodity products for a real increase in the yield of other crops.

Without formation of essential humus stocks in the arable layer of soil to form sufficient moisture reserves, which will ensure the supply of water from crops in the period between rain falls is very difficult. Necessary complex modern scientific research of such issues, taking into account the specificity of specific soil-climatic zones.

Period of maximum use of moisture in the stages of organogenesis in each culture of its own. If in previous times winter crops were able to form decent crops even at the expense of rational use of winter moisture reserves in the soil (in the forest-steppe it is 140-180 mm), then in recent years such a pattern has been violated.

During the growing season in 2017, the average moisture content in the soil after the winter was similar. Why were they not enough to fully realize the productive potential of winter crops not in Kherson, or even in

the Kiev region? What are the reasons for increasing volumes of unproductive soil moisture losses? Previously, information was provided on the growth of heat generation in the regions and, accordingly, the increase in the intensity of processes of transpiration by plants and evaporation of water from the arable layer. However, this is only part of the problem.

Another important part of the problem of the increased loss of water from arable land in the regions is the characteristics of air masses and their modes of movement. Global trends in climate change are not favorable to us. In connection with the general warming, the volume of warm water in the sea current of the Gulf Stream reaching the coast of Europe over the past 30 years has decreased by almost 30%. According to the forecasts of British oceanographers and hydrologists, in these trends, changes in the course of 50 years, the Gulf Stream may disappear altogether and Europe will not receive heat and moisture from the Atlantic Ocean in the traditional volumes for us. The positive impact of the ocean, which softens the temperature fluctuations both in winter and summer throughout Europe, will gradually be lost [5].

The traditional global circulation of air masses over continents is changing. In the spring, in the territory of our country, the decades have become regular winds that carry warm and very dry air masses from the territory of the Arabian Peninsula, which have a relative humidity of 16 to 35%.

It is known that the wind at a speed of 5 m / sec. and more such relative humidity of air leads to real losses of moisture from the soil from 6 to 9 mm per day. It is not difficult to independently calculate for what time of time enough winter moisture reserves in the ground in volume of 100mm.

Accordingly, the preservation of winter moisture reserves is a strategic reserve of water in the soil in the event of unpredictable weather conditions in the first half of the warm period of the year. The problem is how to save it and then use it. Today, agrarians need systematic information on the dynamics of moisture reserves in the soil and the specifics of its losses in all regions of the country throughout the growing season. Very relevant information about the ways, methods and system of measures that reduce the unproductive loss of moisture and optimize water regimes of crops of cultivated plants.

For all the soil-climatic zones of the country, actual measures that can form a favorable microclimate on the fields are becoming relevant. In the first place, techniques are needed to ensure that the ground surface air velocity is reduced to the optimal 1.5-2.0m / sec. and increasing the level of its relative humidity to the optimal 45-80%. Such parameters of the air mode can significantly reduce the intensity of transpiration processes by plants and unproductive water losses from the soil in the crops.

Today, various methods of reducing the loss of moisture from the soil are known to science and production: the use of non-lethal, zero, surface basic treatments, systems of knights and strips, forming on mulch arable lands, the use of harrowing, spit crops, and others. They can partially reduce water losses from the soil and mutually complement each other. At the same time, each of the named agro-preserves has its limitations in practical application.

For example, the system of teenagers can actually be successfully applied only on 10-15% of the area of the country's arable land. The question is not in the sympathies or antipathies of agrarians in such a system of farming, but in the characteristics of soil characteristics in the regions. If equilibrium density of soils

exceeds the values of 1.25-1.27 g / cm3, that is, beyond the limits of optimal density for the successful cultivation of most types of cultivated plants, the introduction of a noutyl on such soils is not appropriate [16].

Each of the mentioned agronomic methods of reducing the loss of moisture from the soil has a corresponding positive impact, but the ways of optimizing the microclimate in the regions are most effective. Protecting individual fields from the effects of negative factors is less effective. Necessary comprehensive systemic measures on significant areas of entire regions.

Such an opinion of the authors is based not only on the rich preliminary scientific and practical domestic experience, which provided, until the 70's of the 20th century, a real cessation of spring dust storms and active deflation processes on arable land in the Steppe and Forest-steppe through forest land reclamation of the territory.

A well-known and significant foreign experience, for example, the USA. The territory of the Great American Plains with an area of 1.3 million square kilometers remotely resembles the territory of our country, both in terrain and in soil, but it has a continental climate with frost in the winter - 25-350C and summer to 400C of heat, with strong constant winds and drylands in summer and relative humidity 10-15% (southern

winds). The precipitation comes from 250 to 600mm per year. Soils in such territories are mostly chernozem (from the 50th parallel) and southern chestnut [8].

As a result of excessive tillage of the territory as early as the 30s of the last century, the region was the result of persistent perennial droughts and dust storms. Modern Great American Plains is an area of intense successful cultivation of spring wheat crops, corn, and in the south of the plains - cotton.

Pragmatic Americans, after decades of scientific research, have come to the conclusion that the most effective measure that can successfully withstand strong winds - drylands and losses of scarce moisture from the soil during the warm period of the year is forest reclamation. Beginning from the end of the 30s and until now, they systematically and consistently plant windbreaks. Only from 1986 to 1995, the area of such plantations in this region of the United States has more than doubled. Such an approach is justified economically and environmentally.

Reducing the velocity of the surface layer of air to 2-3m / sec in one time reduces the intensity of evaporation of available water from the ground in the fields. At the same time, the amount of transpiration of plant plants decreases (the surface air layer has higher relative humidity and low wind speeds).

Modern physiological and morphological studies of cultivated plants that vegetate under different wind conditions clearly demonstrate that staying under the windshift with a speed of 6m / sec. and more, with a low relative humidity (16-35%), leads to a significant stress in the water balance in the tissue of the leaves. Under these conditions, vegetation gradually acquires xeromorphic features of the above-ground parts (water shortage in the above-ground parts and mechanical action of the wind) as a result of intensive transpiration (for example, leafy corn plates are rolled up in the form of tubules) [20, 21, 22]. As a consequence of such vegetation conditions, the level of biological productivity of cultivated plants is reduced.

Accordingly, the yield of crops in fields with a large area that does not have reliable protection against the influence of strong winds, is really far from the same in different areas. It depends not only on the level of mineral nutrition, but also on the intensity of the negative effects of dry air flows and the volume of moisture losses caused by plants and soil as a result of intense transpiration and evaporation. Producers for practical use require the results of scientific research of such impacts taking into account the specifics of all soil-climatic zones of the country.

Modern agrarian production today requires the results of scientific research, conclusions and recommendations that will allow agrarians to better understand the interconnections of cultivated plants in crops with environmental factors: temperature, speed and wind force, indicators of relative humidity, the presence of carbon dioxide in crops, the intensity of transpiration processes and photosynthesis, the rational use of limited moisture reserves in the soil. We need to be able to actively contribute to the processes of optimizing such factors of influence in crops, if we want to have high and stable crops.

All of these issues are relevant and the tasks of modern science must have clear and concrete, scientifically based answers and recommendations for agrarians. What works for landowners to conduct economic activities on arable land, to even under certain adverse environmental conditions, to obtain the required level of crop yields of cultivated plants.

The consumers' approach to arable land, which today is a reality, should end. Modern trends in climate change require a thoughtful and balanced approach to all problems of agrarian production, in particular to the level of arable land fertility and the provision and rational use of available moisture reserves.

The traditional neglect of the real changes in the situation on arable land in the future will lead us, as a society, to the deadlock of the failure to successfully cultivate agricultural crops and the unprofitability of agrarian production in general and the real threat of hunger for the population.

Everything must be done in a timely manner. This is true of such an intricate and multidimensional sphere of human activity as agrarian production.

Conclusions

Water, as an indispensable and indispensable factor for the successful vegetation of plants in connection with climate change for all soil-climatic zones of the country becomes scarce.

The main problem of agrarian production is not how much water deficit arable land, but how much the real inability of farmers to accumulate, store and rationally use it. Irrational losses of water, from the volume of entering the fields during the year reaches almost 80%.

The largest losses of water from arable land occur in the form of evaporation as a result of strong winds having a velocity of 5-6 m / sec and more and a low relative humidity (from 16 to 45%) of air.

Preservation of moisture reserves in the soil for crops of cultivated plants requires an increase in the ability of soils to absorb moisture and retain it with humus and the formation of colloids and reduce unproductive losses due to evaporation.

To reduce the intensity of the processes of evaporation from the soil, its surface should be sufficiently projected to be covered with developed vegetation throughout the warm period of the year. In the process of transpiration of crops of cultivated plants, under high temperatures and strong winds spend up to 80-85% of the amount of assimilated solar energy.

The intensity of transpiration by plants depends on the level of temperature in the region and the strength of the wind and the relative humidity. Accordingly, the presence of developed vegetation, reducing the speed of the surface layer of air and increasing its relative humidity reduces the intensity of transpiration processes at times and provides active processes of photosynthesis and the accumulation of organic substances by plants.

Comprehensive protection of the environment, enhancement of nature's ability to withstand the destructive effects of human activity will effectively reduce the water balance in the regions and provide the necessary level of crop yield.

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