ROLE OF IRRIGATION AND DRAINAGE IN SUSTAINABLE FUNCTIONING OF THE AGRICULTURAL SECTOR IN UKRAINE

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ABSTRACT

Soil and climate in Ukraine are favorable to grow many crops, but the uneven distribution of water resources makes agriculture difficult. Thus, in the South of the country, in many cases, lack of rainfall in the growing season resulted in significant crop losses. The north and northwest part of the country is prone to excess rainfall that leads to oversaturation of soils, and in many cases even to flooding, which also results in crop losses. Thus, the agricultural sector of Ukraine needs intensive reclamation activities: irrigation in arid areas and drainage in the wetlands.

The problems related to the construction of irrigation and drainage systems, reconstruction and modernization the existing ones, restoration of their functioning in connection with the reform of the agricultural sector and the transition to new forms of management are covered in this article.

Keywords: Irrigation, drainage, agricultural sector, water productivity, reconstruction and modernization.

1. INTRODUCTION

Soil and climatic conditions of Ukraine are fairly favourable for the cultivation of many crops. But the water conditions of the country are uneven. Thus, in the South drought is frequent and in the North, especially in the Northwest, there is an excess of moisture. In the first case it is necessary to create irrigation systems, while in the second case - drainage systems to drain the excess water is required.

Approximately two thirds of agricultural lands that include Northern, Central and Southern step areas of Ukraine (approximately 18 million hectares: Mha) are located in the region of insufficient and unstable water supply. There is twice more water that is getting evaporated here compared to water that is being received by these lands. In addition, agriculture in these areas is negatively affected by rainfall uncertainty and droughts recurring every 2 - 4 years. Under these conditions, the agricultural productivity is poor. Agricultural practices in these areas demonstrate that the highest productivity and stability of output can be achieved only through irrigation (Water Management for Global Food Security (2011)).

On the contrary, in the zone of Polissya (Forest zone), located to the West of Ukraine, the agricultural productivity is poor not by the lack of water supply but by the excess of it. In these areas, with too much water, we observe delays in completing the normal agricultural practices, soaking of the crops, and insufficient oxygenation of the root zone. We also register certain processes of alteration of the composition of these lands due to excess water which lead to a considerable decline in crop yields or, sometimes, to complete failure to produce crops altogether. Excessive water in the

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soil here is due to much heavier rainfall as well as the lack of sufficient drainage, and shallow water table.

By draining some water from some of these areas we can increase the acreage of agricultural lands. In addition to increasing acreage of suitable lands, we can also improve the soil quality in these areas, and create optimal conditions for agriculture by regulating the level of the groundwater and the root zone soil moisture (Interrated water resources management (Kovalenko et al., 2005; Kovalenko et al., 2001).

Today this issue becomes more critical due to climate changes, which was confirmed by the data about the amount of active temperatures during crops growing season and annual rainfalls, the annual water balancedynamics, hydrothermal characteristic of regions of Ukraine and zoning according to annual moisture coefficient.

2. METHODS

The research is based on the analysis of the irrigation and drainage systems in Ukraine constructed in the 1960-1990’s, their effectiveness and impact on the stabilization and sustainable development of the agrarian sector of Ukraine. There are about 2.6 million hectares (Mha) of irrigated lands and 3.3 Mha of drainage systems used for maintaining and balancing the sustainable crop growing conditions. In southern Ukrainewell-engineered irrigation systems were set up: the North Crimean Canal, Kakhovska, Inguletska, Krasnoznamyanska, etc., and mostly two-way regulated drainage systems, such as Irpin, Trubizhska and others.

The largest areas of irrigated lands are concentrated in the Step areas – 2.1 Mha, or 84% of the total irrigated area. These lands comprise 8.4% of total agricultural lands and 12.8% of arable lands.

In the Autonomous Republic of Crimea 29.2% of total lands were under irrigation, which is every third hectare. In the Kherson region water was supplied to every fourth hectare, in the Zaporizhya region irrigation lands equaled 13.4%, in the Odessa and Mykolaiv regions 11%, in the Dnipropetrovsk region 10.4%.

In the arid Donetsk region, irrigation from the local sources covered 9.4% of the total area of arable lands. Gradually, irrigation spread to the zones of Forest-Steppe and Polissya (Forest) where the area of irrigation lands equals over 400,000 ha.

3. RESULTS AND DISCUSSION

Analytical studies on existing irrigation and drainage systems have highlighted their importance as a part of sustainable agriculture in Ukraine. Reclamation was the stabilizing factor for ensuring sustainable agriculture. The characteristic feature was the creation of large collective farms. They used powerful irrigation equipment and centralized pumping stations. On-farm networks were made of pipelines that ensure high water use efficiency. Irrigation modules with automated pumping stations were worked out on the area of about 1200-1500 ha. Watering for 96% of the area was carried out by using high-performance sprinkling equipment, such as “Fregat”, "Dnepr", "Kuban". Inter-farm system was automated, which made effective and prompt management of water distribution possible and ensure system operation in on-demand mode.

The system of irrigated agriculture allows growing two grain crops in the same field: winter wheat + millet, or winter wheat + buckwheat, or 2-3 harvests of forage crops. With irrigation, the productivity of agriculture grows by 2-3 times or even
more. Irrigation enabled cultivation of rice, a crop which is new to Ukraine. During the period of 1966-1990 in the areas of Southern Step the average yield of grain crops using irrigation equaled 4.0 to 5.0 tons/ha, while without irrigation it was 2.0-2.3 tons/ha. In other words, irrigation increased grain crop yields by 1.8 - 2 times.

In the years of severe drought the effectiveness of irrigation becomes much higher. For example, in the drought of 1966 the increase of crop yield in the irrigated lands versus lands without irrigation was 2.9 times in the Autonomous Republic of Crimea and 2.1 times in the Kherson region. The results of irrigation are even more impressive for forage crops.

During the period of 1986-1990 the average crop yields in all developed lands equaled the following: grains - 3.3 tons/ha, forage root crops - 45.3 tons/ha, corn for forage and silage - 30.3 tons/ha, sugar beets - 36.0 tons/ha, potatoes - 15.0 tons/ha.

Development of lands with excess water supply enhanced stability of the agriculture production. For example, in the Rivne region where reclaimed lands occupy 31% of the total arable lands, they produce 30% of grain crops, 56% of flax, 30% of potato and almost 50% of perennial grasses for hey. In this region land development promoted considerable growth of the acreage of irrigated lands, strengthened forage basis of livestock, and created jobs and income for villagers.

Drainage combined with proper land usage as a rule pays for itself in 3-4 years. Thus, land development in the areas of excess water gave the decisive impulse to the social and economic development. Unfortunately, examples of land development and their effectiveness are a thing of the past, even though their need is even higher now. The state of irrigation on arid lands as well as drainage in areas of excess water supply is in the decline. For a long time now we do not have those large areas of irrigated lands that produced high and sustainable crop yields (Kovalenko et al., 2004).

As a negative example of today’s practice we can cite a 50% decline of rice production in Ukraine. In the 1990s, the rice systems of the state produced 200,000 tons of rice. Today they produce only 90,000 - 100,000 tons, i.e. less then one half. And this is all-the-while the water to these rice systems is flowing by itself from the Kakhovka water reservoir and without any additional power usage is going straight into the downs. I have to add that these rice systems have been built in the lands of naturally high salinity that are not suitable to any other crops. Rice itself is a great land development crop since after rice is harvested one can observe big improvements in the quality of land.

We can state that the main reason for the decline of water melioration, irrigation and land development in the present conditions of the economy in transition is the lack of the state regulation in this area (Kovalenko et al., 2006).

Land development is the technological and organizational unity of two components: hydro-technologies and land reclamation. The former includes construction and operation of irrigation systems, water supply to and from fields, diversion of water from excess water areas. The latter includes irrigated agriculture, the entirety of means and technologies to produce the highest productivity of land. It is here that we see the final result of water technologies and land reclamation, increasing stability and crop yields, especially in adverse weather conditions.

Construction of irrigation systems always demanded large investments which were financed primarily from the government budget. The main priority of the government policy in this area from the middle of the 1960s was rapid expansion of the acreage of irrigation and drainage lands. Irrigation farming itself was naturally left to the farmers.
It was considered obvious that commissioning of new systems and new acreage would stimulate farmers to develop these lands, increase their farming acreage. And while sometimes there were complaints that the new acreage was being made available too rapidly compared to farmers’ capacities, in general such policies were very effective and justifiable.

Fulfilling a broad program of land development and irrigation at that time was considered the most important government priority. The first task of the Ministry of Agriculture and other authorities in the entire government hierarchy was efficient use of irrigated lands, increase in crop yields, security of soils, correct crop turnover, improvement of organic and mineral fertilizer usage and other means of scientific irrigated agriculture. In other words, irrigation and land development was an integral part of the agriculture, one of the most important conditions of increasing stability and general efficiency of agricultural production. Co-ordination of activities between water and agricultural authorities in regulating technological processes, providing farmers with complete means of production as well as sale of final products - all of that was obtained through the methods of a command system without any significant failures.

For comparison purposes let’s take a look at what we have now, in unfinished and not always successful attempts at reforming the economy.

For example, during the period of 1965-1990 the crop of corn used for animal feed and silage in the areas under irrigation equaled 33.5 tons/ha while in the areas without irrigation it was 12.2 tons/ha. In the drought of 1972 the difference was even starker: 31.6 tons/ha versus 7.2 tons/ha. The same year in the Kherson and Crimea regions the yield of the silage corn without irrigation equaled 3.1 and 3.4 tons/ha, while with irrigation it grew to 28 and 35 tons/ha.

The above data shows that without irrigation, growing forage crops would have resulted in a disaster for livestock.

During years of effective irrigation in the Kherson region, irrigated lands produced 46% of the total crop production, in the Zaporizhya region - 30%, in the Odessa region - 29%, and in the Mykolaiv region - 28%. Irrigation in the Southern step areas produced 77% of corn, 85% of vegetables and over half of the forage crops. In the Autonomous Republic of Crimea the share of forage crops grown in the irrigated lands equaled 64 - 67%. In later years in the Step areas, where there are no natural pastures, irrigation enabled creating long term artificial pastures. It has lead to lowering the total cost of milk production almost by half, and increasing the effectiveness of cows by half as much.

Development of irrigated lands in Southern Crimean Canal command and introduction of irrigation to every third hectare in Crimea has lead to: increasing the total production in agricultural by 4.8 times, meat production by 3.3 times, milk production by 2.8 times, grain crops by 2 times, fruit production by 5 times, and vegetable production by 2.4 times.

Effectiveness of irrigation in Crimea can be also demonstrated by the following example. During the thirty years’ period of 1961-1990, the cost of building irrigation systems equaled 1.225 billion rubles. This investment paid by itself through additional yield of agricultural crops in six years.

For the last 20-25 years radical changes have occurred as the result of the agrarian reform which, in many cases, does not take into account the specifics of irrigation and drainage systems. Large collective farms were eliminated. This led to the violation of the integrity of engineering and reclamation complexes (Kovalenko et al., 2011).
Reclamation potential created on the area of about 6.0 Mha as stabilizing guaranteed reserve for agricultural production under extreme natural conditions, in most cases - periodic drought, was broken. Today from the available 2.18 Mha of irrigated lands only about 0.5 Mha are regularly watered. Of course, in this situation, reclamation is unable to perform its main function - ensuring the sustainability of agricultural production in the face of increasing shortages of natural water supply. In such a situation there are significant fluctuations in gross grain harvest, reaching in some arid years to 20 million tons in Ukraine.

This confirms that irrigation is a necessary precondition to achieve stability of grain and especially vegetables production.

Detailed calculations show that ensuring sustainable agricultural production in dry years is possible only if irrigated areas in the country recover to 3.0 Mha. On the irrigated land it will be possible to receive annually at least 10.5 million tons of grain and total production of grain on reclaimed (irrigated and drained) lands can be at least 20.0 million tones per year, which will allow to have a stable grain production in Ukraine as a whole at least 80 million tones during years with unfavorable weather conditions, and not less than 90 million tons per year with a favorable natural water supply (Transfer of irrigation management services (1990)).

4. **CONCLUSIONS**

Today in Ukraine, the recovery and modernization of irrigation and drainage systems is the acute issue. Increasing their areas is a major factor in the sustainability of the agricultural sector. "The Concept of restoration and development of irrigation in the southern region of Ukraine" was developed in Ukraine and intense negotiations are conducted with the World Bank and foreign partners to attract investments in the restoration and development of reclamation systems. At present World Bank experts together with Ukrainian experts are developing basic Strategic Principles of Land Reclamation. These principles are incorporating global experience of regulating irrigation systems as well as best practices of their reconstruction and modernization. The main priorities of these Strategic Principles are as follows:

(a) Safe operation of irrigation systems and timely repair and maintenance;
(b) Uninterrupted power supply for watering and water deviation according to technological requirements;
(c) Improvement of the administrative structure of irrigation systems through incorporating international best practices of creating water- and land users’ associations;
(d) Reconstruction of irrigation systems that can be salvaged by rebuilding and installing new equipment;
(e) Improvement of ecological security of irrigation through improving reliability of existing collection and drainage systems;
(f) Production and repair of irrigation and drainage equipment;
(g) Reduction of consumption of power and construction materials used to produce and operate irrigation and drainage systems;
(h) Creating drainage systems with two-directional water supply that would allow for regulation of water and air regime of soil;
(i) Saving and improving soil yields in irrigation lands.
Therefore, the sustainable functioning of the agricultural sector of Ukraine as the main source of the country budget revenues can be secured by restoration and expanding of reclaimed land - a reliable "guarantee" of sustainable agricultural production in the country.

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