OPERATING BEHAVIOR OF THE IRRIGATION SYSTEM UNDER OUAI "AQUA" NORTH SOLONEŢ BIVOLARI

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Abstract

The need to rehabilitate and modernize the old irrigation facilities is even greater, due to the fact that most irrigation systems were built before 1989, respecting the functional parameters of that period. Even if some of them have operated at minimum capacities or have been exploited only on certain sections, the physical and moral wear and tear do not allow their exploitation in conditions of maximum efficiency. The opportunity to rehabilitate the old irrigation systems comes with the launch of the National Program for the Rehabilitation of the Main Irrigation Infrastructure in Romania, by PNDR, in 2007. A series of Organizations of Water Users for Irrigation (OUAI) benefited from European funds, submitting financing projects, this being also the case of OUAI AQUA NORTH SOLONEŢ BIVOLARI, from Iasy County. The necessary funds were obtained for the rehabilitation of the Pumping and Pressurization Station SPP 1.b. by Measure 125 a1. Since the commissioning, in 2014, and until now, no malfunctions of the water network and distribution have been registered, nor on the other components of the station. Rehabilitation works were designed, executed and maintained rationally, so that no malfunctions occurred. After the rehabilitation of the irrigation system, production increases were obtained for the corn crop of 6.67% -38.48%, depending on the climatic conditions of the analyzed years.

Key words: rehabilitation of irrigation system, increase production, maize cultivation

The annual rainfall in the area of Moldova is not enough to provide the plants with an optimal water regime, especially in the critical phenophases of their growth and development.

So the need for crop irrigation is an essential condition for obtaining high yields.

The specialized literature offers numerous results obtained for the cultivation of corn in irrigated conditions, compared to non-irrigated corn.

Significant and very significant differences in production increases are reported, depending on the area, the pedoclimatic and climatic conditions of the crop year.

Thus, in the Transylvanian Plain, in the cultivation conditions of 2006-2008, higher maize productions were obtained in irrigated conditions, with up to 2 t/ha, compared to the non-irrigated variants. (Luca E. *et al*, 2009)

Another comparative study, carried out in the period 2008-2010 on maize cultivation, in irrigated and non-irrigated conditions, in addition to the increase in production reported due to water supply to the crop, reported that the optimal density for this crop is 80000 plants/ha. The other variants studied - of 60000 and 100000 plants/ha, respectively, obtained less remarkable results, even in irrigated conditions. (Pandrea R. C., 2012)

Increases in production of 46% of irrigated maize, compared to non-irrigated maize, were reported in the production year 2000-2001, in the pedoclimatic conditions of the Transylvanian Plain. The tested hybrid - Turda Super - showed high productivity characteristics and, benefiting from the optimal moisture input, was used to its maximum potential for its ameliorating characteristics. (Lupuţ I., 2009)

The critical period for water is before the appearance of panicles, until maturity in milk. At these phenophases the soil should have 60-80% water of field capacity. (Axinte M. *et al*, 2006)

In the filling phase of the grains, the lack of moisture causes them to dry out. (Roman Gh.V. *et al*, 2006)

In the pedo-climatic conditions of Moldova, a number of 3 irrigations is recommended, in the following phenological phases of the culture:

- At germination, with a norm of 500-600 m^3/ha;
- At rooting - stage I - 4 days after germination, with a norm of 500-600 m^3/ha;
- At rooting - stage II - 10 days after germination, with a norm of 500-600 m^3/ha;

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Analyzing the soil moisture, 2-3 irrigations were applied, with the norm of 500-600 m^3/ha, depending on the water deficit found.

The rehabilitation of the irrigation system within OUAI AQUA North Soloneț Bivolari was carried out in the period 2012-2013, 2014 being the first year of cultivation that benefited from a production obtained under irrigation conditions.

The rehabilitation of irrigation systems is carried out in order to improve watering performance, using modern equipment, which has a high level of productivity and high reliability in operation. (Luca M. *et al*, 2017; Cismaru C., 2004).

The paper aims to highlight some aspects regarding the behavior in operation of the irrigation system within OUAI AQUA NORTH SOLONEȚ BIVOLARI, from Iasy county, which serves an area of 1428 ha.

MATERIAL AND METHOD

The study and research material is represented by the irrigation systems within OUAI „AQUA" North Soloneţ-Bivolari, which carries out its activity on an area of 1428 hectares, in Iasy County. Pumping station serving these lands - Pumping and pressurization station SPP 1.b. - is part of the Tabăra-Trifești-Sculeni Irrigation Development. (*figure 1*)

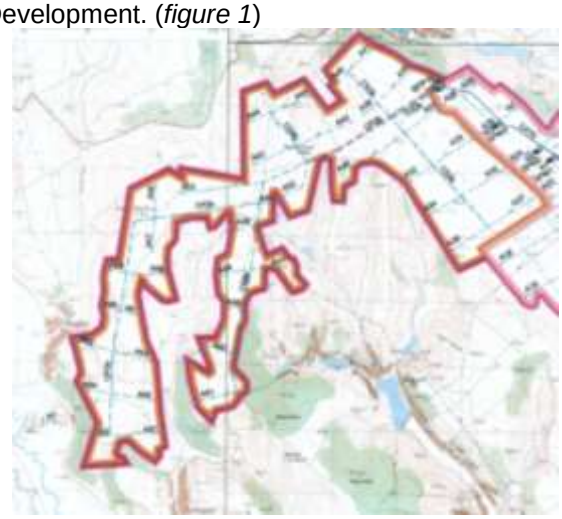

Figure 1 **OUAI „AQUA" North Soloneţ-Bivolari**

The irrigation system is supplied with water taken from the Prut river and pumped with the SPA Soloneţ supply station through the CR 1.b pipe to the SRP1 pumping station.

From here the water is pumped back through the discharge pipe CR 2.b then transported through the open supply channel with trapezoidal section Ca 1.b to the pumping and pressurizing station SPP 1.b. The entire arrangement is located in the Prut meadow.

It was put into operation in 1983 and is made in the wet chamber type, without superstructure.

The current paper presents the results of research conducted within the project Modernization and refurbishment of pumping stations for irrigation of "AQUA North Soloneț-Bivolari, Iasy County.

Annual maintenance and repair costs were analyzed.

There were compared maize productions obtained in two cultivation variants: non-irrigated and in irrigated conditions and observations were made on the increase of production brought by the rehabilitation work of the irrigation system.

Observations were made on the influence of the refurbishment of the pumping station on some consumption indicators and on the operating efficiency.

RESULTS AND DISCUSSIONS

Since the commissioning, in 2014, and until now, no malfunctions of the water network and distribution have been registered, nor on the other components of the station.

Rehabilitation works were designed, executed and maintained rationally, so that no malfunctions occurred.

Maintainance and repair annual costs

Maintenance costs consist of all the materials and labor required to keep the equipment in proper working order.

These are influenced by the number of operating hours, the quality of maintenance work, the annual functionality of the system, etc.

For some components, such as pumps and motors, their degree of depreciation is noted in operating hours.

Operated in optimal conditions for repairs and maintenance, the equipment can operate for up to the duration specified in the regulations. (*table 1*)

The maintenance costs of irrigation systems in the period 2019-2021 are presented in *table 2*.

They consist of the following categories of materials: adhesives, cables, collars, hose coupling, manual dispenser, diesel filters, irrigation generator filters, three-phase plug, hoses, rubber gaskets, sealing paste, fittings, oils and vaseline.

It can be seen that in 2020, where, due to the drought, it was necessary for the installation to operate longer, and its maintenance costs were higher. The additional materials that were purchased for the maintenance of irrigation systems were: coupling with nozzle, nozzle set sprinklers, electrodes, several types of filters (air, oil, diesel), hose of different types, connection of different types, fuses fuses.

The maize productions related to the unit area (kg / ha), cultivated in both variants - irrigated and non-irrigated, as well as the obtained

production increase are presented in *figure 2* and *table 3*.

The highest increase in production, obtained per unit area was recorded in 2020, which was 38.48%. Given the fact that there has been the least rainfall this year, in the last period, the water supply brought by the irrigation system has led to very high production increases.

In the first year of operation, after the rehabilitation works, the production increase was only 6.67%. This increase was not obtained due to the faulty functionality of the irrigation system, but due to the abundant rainfall recorded in 2014. July of that year was declared the fourth rainiest in the last 50 years (Polifronie Elena Mirela, 2014) As a result , very high yields were also obtained for the non-irrigated crop variant.

It is observed that in all the production years analyzed, the irrigated version has much higher values than the non-irrigated version, except for 2014, when remarkable productions were obtained for the non-irrigated version, the year having very favorable climatic conditions.

Regarding ***the influence of the refurbishment of the pumping station on some consumption indicators and on the operation efficiency,*** we can say that through refurbishment the energy consumption was reduced and the efficiency of the installation was increased, thus the objective of the work was achieved.

Even if the design parameters of the pumps have not been changed - the same models have been purchased, due to the fact that they are new models, with current technological requirements, with a lower consumption rate than the old ones, obtaining a higher operating efficiency (*figure 3*).

Table 1

Duration of use and frequency of replacement of various components of irrigation systems

Component elements	Period of use (years)	Depreciation (no of operating hours)
Drilling	20-30	
Pumping stations	20-40	
Centrifugal pumping stations	16-25	32000-50000
Electric engines	25-35	50000-70000
Diesel engines	14	28000
Large channels	40-100	
Small (permanent) channels	20-25	
Concrete constructions	20-40	
Asbestos-cements and PVC pipes	40	
Aluminum pipes for sprinkler irrigation	10-12	
Welded steel pipes	40	
Painted steel pipes, installed on the surface	10-12	
Galvanized steel pipes, installed on the surface	20-25	
Plastic pipes	10	
Sprinklers	8	
Dropping system	8	
Drip filters	12-15	
Drum and hose installations	12-16	5-8
Continuously moving sprinkler systems	10-15	

Table 2

Maintenance costs of irrigation systems within the Pumping and Pressurization Station SPP 1.b

Year	Maintenance Cost (lei)
2019	8918.41
2020	27927.11
2021	12879.83

Table 3

The increase in production obtained from irrigated corn

Year of culture	Production increase obtained for irrigated maize (%)
2014	**6.67**
2015	29.47
2016	32.33
2017	22.16
2018	19.80
2019	26.22
2020	**38.48**

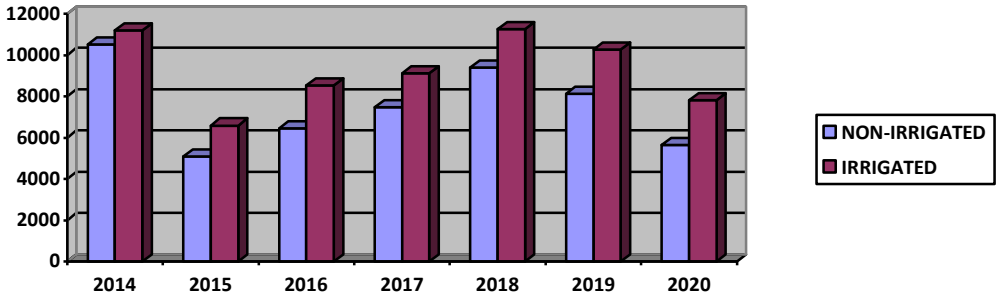

Figure 2 **Productions obtained from maize cultivation, cultivated under irrigation and non-irrigated**

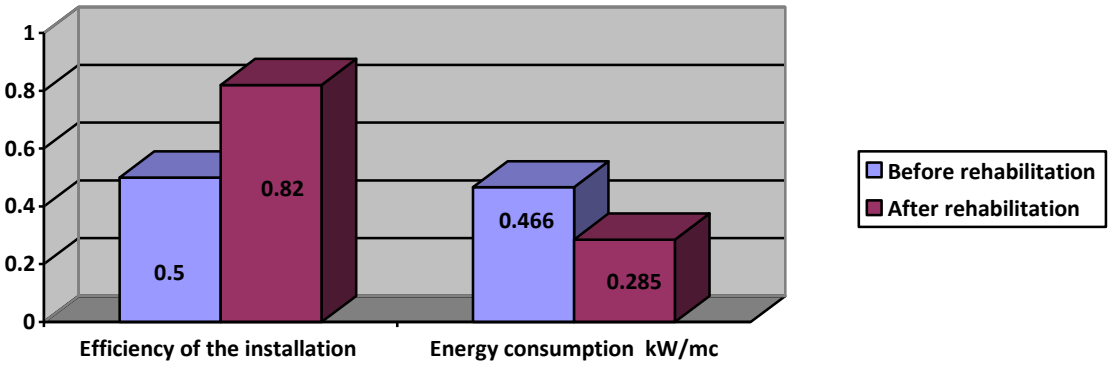

Figura 3 **The influence of pumping station upgrading on the operating efficiency of the pumps and their consumption norm**

CONCLUSIONS

1. Expenditure on the maintenance of irrigation systems is influenced by the number of operating hours of the installations. Further more theesey operate for a longer period and at a higher capacity during periods of drought, when the need for water for plants is higher.

The highest maintenance costs were recorded in 2020, amounting to 27927.11 lei. The lowest expenses were made in 2019, of only 8918.41 lei. This is also justified in view of the fact that the station was put into operation, after rehabilitation, in 2014, with all newly purchased components.

Sufficient funds must be allocated annually for the maintenance and repair of the equipment of the irrigation system, for an operation at optimal capacity, for as long as possible.

2. The highest increase in production was recorded in 2020, of 38.48%, due to very low atmospheric precipitation.

3. By upgrading the pumping station, the energy consumption was reduced by almost 40% (from 0.466 kW / m^3 to 0.285 kW / m^3) and the efficiency of the installation was increased from 0.5% to 0.82%, thus the objective of rehabilitation has been touched.

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