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TECHNICAL MEANS AND SYSTEMS FOR IRRIGATION IN AGRICULTURAL PRODUCTION

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Abstract:

One of the negative phenomena that occurs due to climate change on our planet is long-term dry periods in areas where there were none before. In order to eliminate the consequences as well as the need to improve the physical properties of the soil on which agricultural crops are grown, it is necessary to implement irrigation.

This paper specifies the technical means, methods and systems used in irrigation in the production processes of agricultural crops. From the classic means and systems, channel and irrigation systems, pumps, drip systems, typhoons, rain ramps and rain wings are selected and presented. Today, modern and achievements such as robots, drones and artificial rains are widely used. The paper also lists some examples of irrigation systems implemented in Serbia.

Keywords: Climate change, Irrigation, Classic and modern means and systems

Introduction

The global warming of our planet has been debated in various circles for long time. Scientists, experts, politicians, journalist, layman... are keenly discussing the causes and consequences of this phenomenon. However, the fact is inexorable. Researchers prove it and inhabitants of the planet take heart, Due to global warming, climate changes occur. The consequences are numerous: rising air, land and sea temperatures, melting of frozen areas and glaciers, sea level rise, the occurrence of disasters, storms, floods. And one of these negative phenomena is long-lasting dry periods in areas where there were none before. And this has an extremely large impact on agricultural production because the yields of agricultural crops are reduced and this is reflected in food production. Research centers and experts are looking for solutions to mitigate the effects of drought. Irrigation of the land is one of the most effective measures. That is why special attention is paid to the development of technical means and irrigation systems.

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1. About irrigation

Irrigation is a set of hydrotechnical measures that improve the physical properties of the soil by adding water in order to achieve optimal humidity and thus obtain the highest yields of agricultural crops. It is carried out during the growing season, especially during the dry seasons. Water is used from watercourses, natural and artificial lakes, springs, wells...According to the way of converting the supplied water in the soil, there are three irrigation methods: surface, underground and sprinkling. Archaeological investigations have shown that irrigation of lands was carried out by old civilizations six centuries before Christ. A network of small canals were used in Mesopotamia, in ancient Egypt the Nile River floods, the ancient Nubians had devices in the form of water wheels. Remains of irrigation canals from the fourth millennium BC were found in South America. Chain pumps made by the Chinese in 250 B.C. there were propelled by people with pedals on pulled by oxen. Today, irrigation of fertile land is carried out all over the world. The percentage of use in Asia is around 60%, in America 20%, in Europe 10% and in Africa only 1%. Climatic changes and occurrence of long-term droughts will increase these percentages very quickly. Level of development of technical means for irrigation is an accordance with today level technical achievements. Furthermore, in addition to current classic devices and systems, modern sophisticated systems that are already arriving will be presented in this work.

2. Classic irrigation systems

2.1. Canal irrigation systems

The canal system is the oldest still in use today. Water, mostly from the streams, it is directed using the channel system and leads to those zones that need to be irrigated. Where the terrain configuration allows, the free flow of water is used. Pumps, dams, weirs and culverts are used to overcome the height differences of the terrain.

2.2. Irrigation pumps

A pump is mechanical device whose task is to transport a fluid (liquid) from a lower level to a higher geodesic level or from an area of low to an area of higher pressure. The energy that the pump delivers to the fluid is obtained from the motor. The first pumps that were created in the third century BC as a source of energy used a man or some draft

animals. Today, a steam engine, electric motor, gasoline and diesel engine can be used as an engine. At today, level of development, there is a large selection of different types of pumps on offer. Their division is done according to several criteria. According to the principle operation, they can be dynamic and volumetric, according to the direction of fluid flow, there are divided into axial and radial. According to the construction of the pump and the impeller, we distinguish piston, gear, screw...In the process irrigation, the pump is the most widely used means today, It is usually used in the form of an aggregate consisting of a common block of pump and drive motor.



Picture 1. Pump NSB



Picture 2. Typhoon

2.3. Drop by drop systems

Drop by drop system delivers water directly to the root zone of the plant to be watered. Irrigation is carried out by free fall of water or by means of a pump. The system consists of a network of pipes in which there are drippers, nozzles, sandblasters. Its composition includes the following equipment: pumps, programmers, dripping tapes, filters, dispensers, valves, taps, connectors, forks... Some advantages of this system are: the water flow can be regulated for each plant root individually, possibility of programming, save water, wide application, low price, long service life...

2.4. Typhoon

Typhoon is a mobile system for irrigating large areas in farming, vegetable growing, fruit growing and other areas of agricultural production. The typhoon system consists of the following assemblies: Supporting structure, chassis with wheels; A large drum, a reel, on which the hose is wound; Polyethylene or rubber hose, length from 100

to 800 m, diameter from 40 to 130 mm; Hose for connecting the typhoon and the pump; A pump that should provide adequate water flow (from 3 to 130 m³/h) and pressure (from 1,5 to 2,5 bar); Pump drive (electric motor, gasoline or diesel engine, tractor engine); Mechanical speed reducer; Manometers; Water spray cannon with its own cart; Manometers. Typhoon is usually transported to the watering place using a tractor which is most often used to drive the pump. The cannon enables precise and efficient watering by spraying water up to 60 m in diameter. The length of the hose up to 800 m allows a long distance from the water source. The pump ensures maximum water flow and pressure. Instead of a cannon for spraying water, a rain ramp, i.e., rain wings, can be attached to the typhoon.

3. Modern irrigation systems

3.1. Application of new modern technologies

The development of methods, means and systems for irrigation in agricultural production, today, moves in two directions. One is the modernization and improvement of classic system and the other is the introduction of new modern sophisticated systems. The general development of science and technology and new technical achievements are increasingly present in this area as well. Development centers and experts are rapidly conquering prototypes of new devices with the application of the latest knowledge from various fields such as: computing, software engineering, electronics, robotics, remote control, sensors, artificial intelligence, satellite navigation...

3.2. Robots for irrigation

Robots are already widely presents in various agricultural production processes. Their application makes it possible to replace human labor, increase productivity, reduce production costs, precise work, access to of hard-to-reach spaces, continuous work without breaks and rest, etc. The possibilities of their application are divers. They are used during fruit and vegetable harvesting mechanical tillage, precise planting of plants, dusting, fertilizing, irrigation, collection and analyses of soil samples, sorting and packaging of products...Robots and robotic systems are being developed in Serbia today in several scientific centers in Belgrade, Novi Sad and Niš. Several examples of application of developed robotic systems in irrigation processes are highlighted in this paper.



Picture 3. *Agricultural Robot AgAR*

3.3. Agro drone

Agro drones or drones in agricultural are an increasingly important part of modern technological solutions in agricultural production. Their application is becoming wider and more popular. They bring a lot of innovative solutions when treating crops and agricultural activities. They have a key role for the development of precision agriculture. Drones use GPS navigation and sophisticated sensors that allow them to fly independently and accurately over crops. Their purpose is multifaceted: crop monitoring, spraying with protective agents, determination of soil conditions on large areas and inaccessible locations, precise application of preparations, etc. Using thermal cameras, drones can accurately determine the level of soil moisture, which is key information for efficient and high-quality irrigation. That is why drones will be an indispensable part of modern irrigation systems in the near future.



Picture 4. *Agro-dron*

3.4. Artificial rains

Artificial precipitation induction is the process by which meteorologists increase the ability of clouds to produce precipitation. This method

involves seeding cloud with chemical substances such as silver iodide, potassium iodide, solid carbon dioxide, liquid propane or salts. The presence of these substances in the cloud causes microphysical processes that result in precipitation in the form of rain or snow. Clouds, by the way, consist of tiny water droplets or ice crystals that were formed as result of the cooling of water vapor in the atmosphere and its condensation around dust or salt particles. By seeding the clouds with the mentioned salts, this process is stimulated, the ice crystals become heavy and fall to the ground in the form of rain or snow. Cloud seeding can be done from the ground using balloons or rockets or from airplanes and drones. Causing the appearance of artificial rain in a certain region is a futuristic method that has already found application in several countries around the world. This method of artificial climate change is currently mainly used for irrigation of arid areas, air purification in large cities and cooling of urban areas. Inducing artificial rains, like any new sophisticated method, is accompanied by some doubts. Negative consequences can affect the ecosystem and climate change in neighboring areas.



Picture 5. Part of an irrigation system- rain ramp

4. Same examples of implemented irrigation systems in Serbia

4.1. Danube-Tisa-Danube canal (DTD canal)

Today in Serbia there is one large canal system. Canal DTD connects the rivers in the region of Vojvodina. It was built in 1977. The canal has multiple purposes: land irrigation, drainage, water supply, acceptance of other waters. The total length of this canal network is 960 km and irrigation capacity is 510 thousand hectares. Despite the great possibilities of offers, unfortunately, it has not been fully utilized.

4.2. The first domestic typhoon

In 1992, the zero series of the first domestic typhoons was designed and realized. The participant of this project where Company Tatalovic from Vrsac, Higher Technical School from Zrenjanin and Company IMT from New Becej. The typhoon had irrigation range 600 m, pipeline diameter of 80 mm, supporting structure with two wheels, mechanical reducer with cardan connection for the tractor engine, pump with capacity of 280 liters/min and pressure of 2 bars. The zero series of this typhoon was sold on the Serbian market.

4.3. Solar water pump

In 1988, experts from the then Institute of Mechanical Engineering at the Technical Faculty in Zrenjanin worked on a project for solar irrigation pump. Prototype model development and testing of pump characteristics were performed in the Institutes laboratories.

4.4. Production of drop- by- drop systems

Given that the production of the elements of this system is relatively simple and at a lower technological level, a large number of producers have appeared in Serbia to date. This program is particularly interesting for small businesses. In one period, an entrepreneur from the place of Ecka near Zrenjanin was also present on the market. The company Metal plast from Knjazevac stands out as a manufacturer today.

4.5. Modern integrated drop to drop system

In place Banatsko Karadordevo near Zrenjanin a modern integrated complex drop be drop system operates. He irrigates plantation on 17 hectares . Water for watering is obtained wells using pumps with electric motors. The necessary electricity is obtained from a solar panels are spherical in shape and are controlled by servo devices. Besed on the coordinates of the Sun from satellite, the servo devices rotate the solar panels, wich thus follow the path of the Sun during the duy. In this way, maximum utilization of solar radiation is obtained.

4.6. Remote irrigation management

The Remote irrigation management project was implemented by the Mihajlo Pupin Institute from Belgrade. It is intended for optimal management of water, soil and energy. This kompleks system has been implemented by several large domestic agricultural producers.

4.7. Mobile robotized solar power generator for irrigation

The Technology Transfer Center at University of Belgrade has developed a Mobile robotized solar power generator for irrigation. This complex systems has a power of 3,5 kw, can be transported on a trailer and is intended for irrigation.

4.8. Universal agricultural robot AgAR

The company Coming Computer Engineering from Niš and Faculty of Mechanical Engineering from Niš developed the AgAR Universal Agricultural Robot. The project was declared the best regional innovation. The purpose of this robot is to replace human work in various jobs in the field such as irrigation, spraying, planting, fertilizing, weeding. The robot is in the phase of experimental testing.

5. Conclusion

In this work, a selection of the most important means used irrigation processes was made. Devices and systems from the simplest channels to modern sophisticated robotic and artificial rain presented. In addition to being applied to achieve optimal soil moisture they can also be used to improve its quality, feed and protect plants and more. With the arrival of climate changes and appearance of long-term droughts, the development and application of these means and systems becomes extremely important.

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