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Smart Watering Solutions doo

Case study on the topic:

Sensor based drip irrigation automation brings savings in water consumption of 17% and 4 times less labor is used for irrigation management

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1 INTRODUCTION

The subject of this document is a case study on the topic of how the company Delta Agrar doo managed to achieve significant savings in its orchard using irrigation automation software that, with a help of sensors in the soil, independently starts and stops irrigation

Delta Agrar doo is a member of Delta Holding and has been present in agribusiness since 1993. and as such today represents one of the leaders in all aspects of agricultural activities.

In the part of primary production, Delta Agrar is engaged in farming, fruit and vegetable production, livestock and fishing. Production is carried out on five agricultural estates owned by Delta Agrar, on an area of 11,000 hectares.

In 2007, Delta Agrar built one of the most modern apple orchards in Southeast Europe on its property AD "Podunavlje" in Čelarevo. In 2017, production was expanded in the city of Zaječar.

Today, the orchards have a gross area of **700 hectares** (Čelarevo and Zeječar). The estate in Čelarevo produces world-famous varieties of apples, such as: **Gala, Golden Delicious, Red Delicious, Granny Smith, Breburn marriri red, Kiku, Pink Lady and others.**

The apple is planted at a distance of 3.2 x 0.8 m, which ensures that there are 3900 plants on one hectare. Some areas are also raised by planting to 3.2 x 0.6 m, which gives 5200 seedlings per hectare, which is more intensive production.

In addition to planting density, high and stable yields are also affected by: seedling quality, protection from unfavorable climatic factors, **quality irrigation and fertilization.**

The orchard is equipped with an antifrost system, an irrigation system (drip irrigation system), a fertigation system and a hail protection system. **The irrigation system and meteorological stations** cover the entire surface of the orchard and, with the help of GPRS, enable remote control and monitoring of data.

The entire production of apples takes place according to the **GLOBAL GAP** system, which enables export quality.

2 BEGINNING OF THE EXPERIMENT

Many years of experience of experts from Delta Agrar led to the conclusion that reliance on calculations of irrigation regime through water balance and evapotranspiration is not accurate enough because it often happened that visual observation of plants in the orchard, could make it seem that plants are too humid, or clogged with a large amount of water. Based on the obtained information and the need to increase the yield, apple quality, efficiency and optimization of the workforce in Čelarevo, a decision was made to set up a test field with a Smart Watering device on 12.3ha and control field at the same location was established on area of 12.8ha.

Testing was set up to examine whether it is technically possible to **fully automate an irrigation system** with sensors in the field, what results and what savings automation with sensors will provide. The primary idea was to test whether and by how much irrigation efficiency will increase, how much will be saved, what will be the reaction of plants, what will be the yields and finally the most important thing **is whether the investment in such a system is economically justified**. The goal was also to reduce the labor force, that is to what extent the use of workers in irrigation operations can be omitted.

Based on all of the above, Delta Agrar and Smart Watering have embarked on a pilot project to automate the most modern apple orchard in this part of Europe.

3 TEST FIELD

There are 4 irrigation zones in the test field. In the field there is a Smart Start controller that drives 4 solenoid valves with a diameter of 3 "and a nominal flow of 27 m³ / h, or 4 irrigation zones. There is a flow sensor on the main line that informs how much water has been consumed and how much water has reached each plant. In each zone there is a measuring station with a probe that measures soil moisture at 6 depths(10cm, 20cm, 30cm, 40cm, 50cm, 60cm). Two zones of the Granny Smith apple and two zones of Red Delicious are irrigated via Smart Watering

The layout of the map of the installed system can be seen in the image below.



Picture 1. Layout of the map for irrigation under Smart Watering device

Experiments and measurements in the field where the Smart Watering system was installed were done in 2019 and 2020. The experiment was done during the irrigation season, in 2019 from March to August, and in 2020 from April to September. The testing was done on chernozem type soil, and according to the texture class (Tommerup) it is clayey loam.

3.1 The course of the examination

3.1.1 Examination 2019. year

The data obtained in the 2019 irrigation season largely coincide with the data in 2020.

The text below shows the amount of water used for the fields under the Smart Watering device.

Table 1 – Annual water consumption in the fields under SW

The amount of water m ³ Smart Watering				
	P10 3 smaller field	P 10 3 bigger field	P10 4 smaller field	P10 4 bigger field
March	158	130	158	158
April	823	664	874	824
May	389	280	374	310
Jun	1095	865	1400	1510
July	1655	1385	1920	2270
August	1480	540	1305	1885
SUM	5600	3864	6031	6957

Water consumption is measured using a pulse flow sensor that is connected to the controller and sends flow information to the cloud where all data is recorded in the database.

The following table shows the amount of water consumed on the same area and on the same varieties in an orchard that is not irrigated by Smart Watering, but by a regular irrigation system.

Table 2 – Annual water consumption in the field of regular irrigation

The amount of water in m ³ regular irrigation				
	P10 3 smaller field	P 10 3 bigger field	P10 4 smaller field	P10 4 bigger field
March	240	240	210	210
April	955	955	905	910
May	360	360	325	325
Jun	1465	1465	1390	1400
July	2310	2310	2150	2180
August	1965	1965	1875	1910
SUM	7295	7295	6855	6935

The water consumption of an orchard where there is no SW is calculated based on the average flow of the section, which in normal operation is 27 m³ / h, measured by the built-in flow sensor and the regular operating time of the system on the rest of the orchard.

When looking at the tables with water consumption, it can be seen that the total water consumption for 2019 in the part where the Smart Watering device is installed is 22,452 m³, and where there is no Smart Watering is 28,380 m³. These figures show that for the mentioned year, **as much as 17% of water was saved on the part that was irrigated automatically by sensors.**

In addition to saving water using Smart Watering, it also saves time, ie less human presence in the orchard is required. Employees at Delta Agrar for 2019 had 229 regular tours of the orchard in connection with irrigation operations, and 50 tours in the orchard equipped with Smart Watering. Which means that **Smart Watering saves time in addition to water**, in this case it was 4.58 times less necessary to visit a part of the orchard with Smart Watering equipment.

3.1.2 Examination 2020. year

That 2019 was not accidental is also shown by the results achieved in 2020.

In table no. 3 below shows the water consumption under the Smart Watering device for 2020.

Table 3 – Annual water consumption in the field under SW.

The amount of water m ³ Smart Watering				
	P10 3 smaller field	P 10 3 bigger field	P10 4 smaller field	P10 4 bigger field
March	/	/	/	/
April	1277.42	941.62	1496.84	1373.1
May	462.3	494.04	475.64	462.3
Jun	621.46	598	555.22	621.46
July	1187.352	788.532	1166.744	984.86
August	587.65	562.35	750.03	663.55
September	843.64	943	892.4	819.72
SUM	4979.822	4327.542	5336.874	4924.99

The table below shows the water consumption in fields that were not irrigated by Smart Watering devices

Table 4 – Annual water consumption in the field of regular irrigation

The amount of water m ³ regular irrigation				
	P10 3 smaller field	P 10 3 bigger field	P10 4 smaller field	P10 4 bigger field
March	/	/	/	/
April	1260	1260	1060	1060
May	752	752	693	693
Jun	864	864	796	796
July	1680	1680	1560	1560
August	950	950	858	858
September	696	696	1129	1129
SUM	6202	6202	6096	6096

It is easy to conclude that in 2020, 19,569 m³ of water was used under Smart Watering, while 24,596 m³ of water was used for the same area without the use of Smart Watering. This data shows that in 2020, **17% of water was saved**.

For the mentioned year, Delta Agrar workers had 177 regular tours of orchards, and 44 tours under the Smart Watering system, which is 4 times less than usual.

3.1.3 Percentage ratio in irrigation for 2020 year

The table below shows the percentage difference in irrigation for 2020. The table shows more precisely in which flood zone and in which month, with the use of sensors and applications, more or less water was given and in what percentage.

Table 5 – Ratio by months

Percentage ratio				
	P10 3 smaller field	P 10 3 bigger field	P10 4 smaller field	P10 4 bigger field
March	/	/	/	/
April	1%	-25%	41%	130%
May	-39%	-34%	-31%	-33%
Jun	-28%	-31%	-30%	-22%
July	-29%	-53%	-25%	-37%
August	-38%	-41%	-13%	-23%
September	21%	35%	-21%	-27%

4 CONCLUSION

The research showed that in some parts of the orchards where irrigation is done with the help of sensors and Smart Watering application, it gave drastically less water, and the yield, quality and result at the end of the year remained unchanged.

It can be seen from Table 5 that in some parts of the orchard that was irrigated via the Smart Watering application in certain months, more water was given than where it was irrigated via evapotranspiration and water balance. This means that irrigation via applications and sensors does not necessarily mean saving water, but giving the plants as much water as they need at a given moment.

Despite the fact that some parts of the orchards were irrigated more, and some less, the total savings on water consumption on an annual level is slightly more than 20% or about 5,000,000 liters of water on an area of 12,3ha, which is a saving of 406,504 liters / ha.

In addition to irrigation, less lushness, calmness of seedlings and with unchanged fruits size and quality were observed on plants under the Smart Watering system.

Saving water also leads to energy savings brought by reduced water pump starts when irrigation is not required.

Savings have also been observed in the workforce, where the presence of labor in the fields with the Smart Watering device is reduced.

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