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Analysis of the effects of farm fitting out with the installation for horticultural crops irrigation

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Abstract: *Analysis of the effects of farm fitting out with the installation for horticultural crops irrigation.* The effects of fitting out the horticultural farm with irrigation installation are presented. The scope of work covered the labour inputs and exploitation costs. The total production profit analyzed in 2012, resulted from irrigation system implementation, amounted to about 30 000 PLN, when compared to the previous year without irrigation. The calculated predicted refunding of investment cost inputs will occur in the third year of irrigation system utilization; it is a significant argument that proves the rightness of fitting out the farm with overhauling hose-reel sprinkling machine and with auxiliary assisting devices.

Key words: farm, costs, irrigation, refunding period, horticultural production.

INTRODUCTION

Geographic position of Poland and the moderate climate create the favourable conditions for cultivation of majority of field vegetables on the entire area of the country. However, these crops are concentrated mainly in five provinces: mazowieckie, łódzkie, wielkopolskie, małopolskie, kujawsko-pomorskie (59% of vegetable cultivation area and 62% of total vegetable production).

The weather conditions (temperature distribution, precipitation amount) are the main factors that determine the length of vegetation period, which, depending on the region, lasts on the average 180–210 days. It enables to obtain the satisfactory yield of vegetables, coming from both the moderate and worm climates [Kaniszewski 2007].

Under climatic conditions of our country, as a result of insufficient precipitation during plant growth, the water shortage occurs very often; it causes substantial variation of yield and its quality in particular years. Similar problems occur in many regions of the world; it justifies the need of proper planning of plant production under conditions of uncertainty connected to the balance of available water [Raul et al. 2012].

According to Baca [1980], about 24% of Poland's area is taken by lands of adverse water budget with water shortage of 100 mm, the average conditions with water shortage of 40–60 mm occur on the area of 16.6%, and only 13.9% of area is characterized by the active water balance.

In the case of a series of consequences resulting from the lack of appropriate water resources available to cultivated plants in the specified time of vegeta-

tion, providing plantation with necessary amount of water that determines the obtained yield becomes a key factor [Gaworski 2012]. In that case, the water supply is an element of system approach to water management for agricultural needs, with consideration to the effects of innovation implementation [Pasternak et al. 2011].

The work aimed at analysis of the effects of fitting out the selected horticultural farm with an installation for irrigation.

MATERIAL AND ASSUMPTIONS OF ANALYSIS

The farm where analysis was carried out in respect of technological improvement in vegetable production with consideration to the irrigation system investment, is situated in the łodzkie province in Piątek commune. The total farm area amounts to 17.8 ha, including 13.5 ha of arable land (GO) and 4.3 ha of grassland (UZ). Production is carried out on relatively good soils of valuation classes ranging from II to V, with majority of III class.

The vegetables are very demanding in respect of water requirement; therefore, under conditions of central Poland (where the analyzed farm is situated) one should supplement the water level needed for proper plant growth by the amount of 200 mm, i.e. 2000 m^3 per 1 ha of area.

In the case of analyzed farm, the annual amount of water (at average precipitation) used for irrigation should amount to 16 000 m^3. For vegetables cultivated on the farm (cabbage, cauliflower, carrot, celery, leek and Chinese cabbage) one can estimate that the sprinkling machine is unwound six times per year on the area of 1 ha (as in 2012) at average water dose of 20 mm. The sprinkling machine was unwound 40 times on the area of 8 ha. Irrigation of 1 ha lasted 6 hours on the average; that gave 288 operational hours during the entire season.

According to assumptions, the exploitation period of sprinkling machine should amount to 15 years, while for a deep well pump to about 10 years, without general overhaul.

The labour inputs for service, exploitation and supervision during one irrigation with the system amounted to about 2 hours, and 80 hours during the whole season.

The irrigation costs should also include the time of water pumping from a deep well to a pond; it amounted to 320 hours in 2012.

RESULTS OF INVESTIGATIONS AND DISCUSSION

The irrigation system investment included purchase of the following items:

- Hose-reel sprinkling machine;
- Deep well pump with a float that was placed on the pond;
- 800 m of hose to supply water to 8-ha area surrounding the farm;
- Hoses and couplings for assembling the entire installation.

Total costs that covered purchasing of mentioned elements and electrical energy supply amounted to 68 950 PLN.

Basing on information gathered in the farm and observations made in 2012, as well as opinions of producers that used the same solutions, the annual exploitation costs of irrigation system are presented in Table 1.

The exploitation cost per hectare amounted to 1549.65 PLN, while that per one operation to 309.93 PLN. If depreciation of agricultural equipment of 14% (based on the Cabinet's decree of 10.12.2010 on Capital Assets Classification) is not taken into account, the cost of single irrigation of 1 ha area is considerably lower and is equal to 127.75 PLN at water dose of about 20 mm.

Basing on gathered information and investigations carried out in 2011/2012 one can find a very distinct effect of irrigation operation application on the production indices in the investigated farm. Not only the yield of total vegetable production increased by 20% due to irrigation, but quality of vegetables was far better and there was no problem with the sale of vegetables.

The yield increase (excluding the cauliflower production sold by the piece) achieved as a result of irrigation application is presented in Table 2.

The yield increase of all vegetables grown in the farm can be found in relation to the previous year, when precipitation was the only source of water for the plants.

The yield increase due to irrigation is closely related to profit and, thus, profitability of production (Tab. 3). The annual

TABLE 1. The annual irrigation cost in the farm with consideration to equipment depreciation

Parameter	Calculations	Cost [PLN·year^{-1}]
Electrical energy consumption of deep well pump on the pond	0.63 [PLN·kWh^{-1}] × 11 [kW] × 288 [h·year^{-1}]	1 995.84
Electrical energy consumption of pump in the well	0.63 [PLN·kWh^{-1}] × 4 [kW] × 320 [h·year^{-1}]	806.40
Fuel consumption for transport and sprinkling machine unwinding	3 l diesel × 5.90 [PLN·l^{-1}] × 40 [year^{-1}]	708.00
Labour	20 [PLN·man-hour^{-1}] × 80 [man-hour·year^{-1}]	1 600.00
Depreciation of sprinkling machine and pump	14% of 43050 [PLN] + 9000 [PLN]	7 287.00
	TOTAL:	12 397.24

Source: own calculations.

TABLE 2. Yield increase as a result of vegetable plantation irrigation in the farm

Vegetable	Area [ha]	Yield (2011) without irrigation [t]	Yield (2012) with irrigation [t]	Yield increase [%]
Early cabbage	1.5	45	55	18.2
Carrot	1	55	64	14.1
Celery	1	25	34	26.5
Leek	0.5	14	19	26.3
Onion	1.5	40	47	14.9
Chinese cabbage	2	75	93	19.4

Source: own investigations.

TABLE 3. Profit obtained as a result of sprinkling in 2012

Vegetable	Yield increase due to Irrigation [t]	Average price of 2011/2012 season [PLN/kg]	Profit [PLN]
Early cabbage	10	0.60	6 000
Carrot	9	0.50	4 500
Celery	9	0.90	8 100
Leek	5	0.80	4 000
Onion	7	0.40	3 500
Chinese cabbage	17	0.50	8 500
		Total profit	34 600

Source: own investigations.

TABLE 4. Expected period of investment repayment in the analyzed farm

Analyzed parameter	Value
Cost of investment in 2012	68 950 [PLN]
Profit of irrigation application, less the costs of sprinkling machine utilization	29 490 [PLN]
Expected period of investment repayment	2.34 [year]

Source: own investigations.

cost of sprinkling machine operation on the area of 8 ha amounted to 5110.24 PLN (without depreciation) is somewhat less than 15% of the profit, obtained due vegetable irrigation on the investigated area. Therefore, the profit obtained due irrigation, less the cost of sprinkling, amounts to 29 490 PLN; this very distinctly testifies for the rightness of application of the analyzed operation.

In the case of vegetable field production, the determination of investment repayment period is very difficult. Such production is burdened with a great risk connected to weather conditions: drought, ground frosts, floods due to intense precipitation. All these weather factors greatly affect the crops production. Apart from unfavourable weather conditions, over-production of vegetables often occurs, that results in low profitability. The knowledge and experience of the farmer also determine the final production effects. Therefore, in respect of repayment of the inputs for carried out investments one should take pattern of previous years only and believe that the subsequent years will be similar from the viewpoint of weather conditions or production profitability.

The expected period of investment repayment in the analyzed farm is presented in Table 4.

Basing on carried out analysis on irrigation technical infrastructure effectiveness one can find, that the expected repayment of inputs will take place in the third year of installation utilization.

SUMMARY

The investment made in the analyzed farm is profitable from many points of view. Not only a substantial yield increase can be achieved due to crop irrigation, that results in higher profits of produ-

ction, but also quality of vegetables is improved; they have better competitive value on the market, especially at the stage of selling.

The profit of total 2012 production increased due to irrigation by over 30 000 PLN when compared to the previous year without irrigation. The expected period of investment cost repayment in the third year of irrigation system utilization is the next argument for rightness of the purchase of hose-reel sprinkling machine and auxiliary assisting devices.

The chosen hose-reel sprinkling machine is well justified. This solution fits well to cultivation of various field vegetables, independently of their height and field configuration. The advantage of sprinkling machine over other installations for irrigation consists in its mobility, i.e. possibility of installing on any site of any inclination and on any, even poor soil. Irrigation with then use of sprinkling machine is the most economic method of water management. This system enables to adjust intensity and duration of sprinkling, thus, can be easily adapted to different requirement of cultivated plants. A very important advantage of sprinkling machine is the possibility of its application in struggle against ground frosts; the machine can be used in additional feeding of plants with mineral fertilizing solution. Combining of a reel with a very efficient and energy-saving deep well pump reduces the costs of irrigation when compared to other methods for supplying sprinkling machine with water.

Considering higher and higher production costs, the farmer dealing with horticulture cannot undertake the production risk connected to more and more often drought periods in our country. Even if the total sum of precipitation during vegetation period is high, there occur the periods of water shortage. Therefore, one can control of this unfavourable weather factor only due to irrigation, that can lead to the increased production effectiveness [Florczak 2013]. Achievement of certain level of production effectiveness should not be the factor that limit the systematic implementation of innovations in horticultural production. The example of modern approach to irrigation is its combining with mineral fertilizer application; it allows for an increase in productivity and its evaluation [Podsiadło et al. 2005].

REFERENCES

BAC S. 1980: Celowość nawadniania na tle klimatu. Materiały Konferencji NOT nt. Problemy nawodnień użytków rolnych w Polsce, Bydgoszcz.

FLORCZAK M. 2013: Analiza efektywności wykorzystania technicznej infrastruktury do nawadniania upraw na przykładzie wybranego gospodarstwa ogrodniczego. Praca magisterska (maszynopis), WRiB, SGGW, Warszawa, ss. 53.

GAWORSKI M. 2012: Nawadnianie, zabieg często niezbędny. Agrotechnika, nr 05/2012.

Kaniszewski S. 2007: Produkcja warzyw w Polsce. Stan obecny i perspektywy. Hasło Ogrodnicze, nr 04/2007.

PASTERNAK D., WOLTERING L., NDJEUNGA J., WANI S.P. 2011: Innovative and sustainable approaches for agricultural water management in the drylands of the developing world. Acta Horticulturae, No 922, p. 121–131.

PODSIADŁO C., JAROSZEWSKA A., ROKOSZ E. 2005: Efektywność ekonomiczno-produkcyjna nawadniania i nawożenia mineralnego wybranych warzyw. Inżynieria Rolnicza, nr 4 (64), s. 125–133.

RAUL S.K., PANDA S.N., INAMDAR P.M. 2012: Sectoral conjunctive use planning for optimal cropping under hydrological uncertainty. Jour-

nal of Irrigation and Drainage Engineering, No 2 (138), p. 145–155.

Streszczenie: *Analiza efektów wyposażenia gospodarstwa w instalację do nawadniania upraw ogrodniczych*. W pracy przedstawiono analizę efektów wyposażenia gospodarstwa ogrodniczego w instalację do nawadniania. Zakresem pracy objęto nakłady pracy i koszty eksploatacyjne. Rozpatrywany w 2012 r. zysk z całkowitej produkcji, wynikający z wdrożenia systemu nawadniania, kształtował się na poziomie ok. 30 000 zł w porównaniu do roku poprzedniego, bez deszczowania. Obliczono, że przewidywany zwrot kosztów poniesionych na inwestycję nastąpi już w trzecim roku użytkowania systemu nawadniania, co jest ważnym argumentem przemawiającym za słusznością zakupu deszczowni szpulowej oraz urządzeń wspomagających jej pracę.

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