TECHNICAL AND TECHNOLOGICAL FACTORS AND ECONOMIC RESULTS IN WATERMELON PRODUCTION

Mladen Jurišić[1], Jozo Kanisek[2]

[1]Faculty of Agriculture in Osijek; Croatia,
[1]Faculty of Agriculture in Osijek; Croatia,

Abstract

Watermelon production in Croatia has stagnated for a number of years and it could be mostly found on individual farms as their source of income in summer months. According to official data, production in Croatia in the year 2005 amounted to 66.280 tons. Growing watermelons from transplants is the most intensive way of production and it provides the highest yield. In combination with polyethylene mulch and drip irrigation it provides a stable and early yield.
Transplants on mulch with drip irrigation were used in our example. The subject of research of this paper is organization of watermelon production on the area of three hectares. Based on calculated standards and developed technological map, the consumption of 44,3 hours of machine work and 332 hours of human labour per hectare were determined. The total costs amount to €3.475,38, and, with 120 tons of yield and production value of €4.563.65, the realized income was €1.088,27. Based on the coefficient of economy of 1,31, the conclusion was made that watermelon production is efficient, and every €100 invested in production resulted in €31,3 of profit.

JEL classification: O13

Keywords: watermelon production

Introduction

Watermelon is a very old crop originating from the central and southern areas of Africa, where wild and semi-wild types of watermelon can be still found even today. In Europe, watermelon is mostly produced in Greece, Italy, Spain, Romania and Russia.
Watermelon production has no larger significance for economy, but still it has a significant importance for nutrition of population. Watermelon production in Croatia has stagnated for a number of years and it could be mostly found on individual farms as a source of their income in summer months. In the past few years there was a need for larger areas and larger investments in watermelon production, but such investments were never realized to larger extent due to high dependence of the crop on climate

conditions and uncertain end result. Watermelon is mostly grown on individual farms as „bostan“, in combination with melon (Jurišić, 2009). According to FAO data, the world watermelon production amounts to approximately 100 million tons (97.537.564,16 t in 2005). The Table 1 provides account of the world's largest producers. According to official data, production in Croatia in the year 2005 amounted to 66.280 tons.

Table 1: World watermelon production in 2005 according to FAOSTAT (in 1.000 tons)

COUNTRY	China	Turkey	Iran	USA	Brazil	Egypt	Other
PRODUCTION	69.213	3.970	3.260	1.718	1.505	1.500	16.371

In addition to vitamins and minerals, watermelons are also rich in lycopene, which is a very important anti-oxidant, important for cancer prevention and preservation of blood vessels.

Production structure on Kovanović family farm in the village of Soljani (Eastern Croatia)

Kovanović family farm in Soljani has a rich farming tradition. After the break up of the cooperative and limitation of land ownership imposed by the state, crop and livestock production on the farm were continued in the form of an independent family business. After the Croatian War of Independence, arable land area was increased through buying of smaller farms and through land holding and the farm was oriented to crop production.

The total currently cultivated area of the family farm is 86 ha, of which 68 ha is rented and 18 ha is in permanent ownership of the farm.

Kovanović family farm has been engaged in production of larger quantities of watermelons for the market for some 15 years, on smaller areas (up to 10 ha). Watermelon is a suitable crop, because most of the labour intensive works related to watermelon production are done at times when there is no other significant crop farming work to be done. After several years of experimenting with different watermelon production methods (in the field, under mulch with raining irrigation, transplants, etc.), the conclusion was reached that planting very early sorts of watermelon on a smaller area is the most feasible way of production. This refers to watermelons grown from transplants, under mulch and with drip irrigation on the area of 3 ha.

Climate conditions during vegetation

Analysis of climate conditions during watermelon vegetation period (April – mid-August) is given in the Table 2. The Table indicates high

daily temperature, which resulted in increased transpiration and consumption of water which then had to be supplied to the plant through irrigation system.
Precipitation during this period was lower than the average annual precipitation, which could have lead to a serious decrease in yield. The whole area was covered with irrigation system, and the only disadvantage of lack of precipitation was an increased quantity of fuel needed for the pump, and as such it presented only a temporary material loss. The lack of precipitation at the same time reduced the quantity of present weeds and thus reduced the need for investment in herbicides and labour force that would be needed for hand hoeing.

Table 2: Maximum, average and minimum daily temperatures during vegetation

Temperature:	Maximum	Average	Minimum
Maximum temperature	40 °C	26 °C	13 °C
Average temperature	30 °C	19 °C	9 °C
Minimum temperature	20 °C	12 °C	1 °C

It can be observed from the Table 2 that temperature movement in this period was in accordance with temperatures needed for watermelon development, with no extreme conditions that might harm the development of the plant or the fruit.

Watermelon fertilization on Kovanović family farm
The type and the amount of fertilizers that were deposited and ploughed in the soil during autumn fertilization are given in the Table 3. The Table 4 gives account of the type and amount of fertilizers added into soil during spring soil cultivation as nutrition reinforcement.

Table 3: Autumn fertilization

FERTILIZER TYPE	APPLIED IN TOTAL (kg)	TOTAL AREA (ha)	AMOUNT (kg/ha)
MANURE	100000	3	33000
NPK 7:20:30	1200	3	400
NPK 0:28:20	400	2	200
UREA	450	3	150

Table 4: Pre-emergent soil fertilization and nutrition reinforcement

FERTILIZER TYPE	TOTAL DISTRIBUTION	AMOUNT / ha	DISTRIBUTION METHOD	DISTRIBUTION PERIOD
NPK 15:15:15	1500 kg	500 kg	SPREADING	PRE-EMERGENT
PROFERT MARA	6 l	2 l	FOLIAR	VEGETATION
MEGAGREEN	6 kg	2 kg	FOLIAR	VEGETATION
KRISTALON GREEN	120 kg	2 x 20 kg	FOLIAR	VEGETATION
KRISTALON RED	120 kg	2 x 20 kg	FOLIAR	VEGETATION

In addition to foliar nutrition, Profert Mara and Megagreen were also used for fertilization and stimulation of growth of transplants in a greenhouse. According to producer's instructions, several treatments would be necessary for optimum utilization of these chemicals, but they were used only once due to good soil preparation.
Kristalon is a water-soluble fertilizer developed to reinforce nutrition of all plants with exactly what they need and when they need it. Kristalon can be applied on all crops outdoor or under protection, on vegetables, fruits, flowers and decorative plants, with drip irrigation, sprinkling, spraying, or other irrigation systems. All Kristalon fertilizers are labelled by colours in order to provide easier differentiation.

Watermelon seeding on Kovanović family farm
The seed for sowing was purchased from the seed distributor „Pro – Agro" d.o.o. za trgovinu i usluge *(trade and services)* – in Županja. Hybrid seed is usually sold by "piece" in packages from 100-1.500 seeds, mostly in vacuum bags, but often also in cans (Harris-Moran hybrids).
Based on the results from previous years, the decision was to grow four different hybrids in order to provide different ripening periods and more stable yields.
Farao F1 - a medium-early hybrid with the vegetation period about 70 days from the day of transplanting. Plants are extremely exuberant. Fruits are oblong in shape, weighing about 12 kg. The rind is striped in marble fashion, the flesh is light red. This hybrid is intended for growing in open field and in low tunnels.

Celebration F1 - a medium-early hybrid with vegetation period about 80 days from the day of transplanting. Plants are extremely exuberant, and fruit setting is very good. Fruits are oblong in shape, weighing 12-15 kg. The rind is thin and striped in marble fashion, the flesh is dark red. The fruit quality is extremely good, even after the optimum harvest period. This hybrid is intended for growing in open field on mulch. This hybrid also travels well.
Fantasy F1 – early hybrid of medium exuberance, with oblong fruits weighing about 10 kg. The rind is medium thin, with marbled striped surface. The flesh is dark red, very sweet in taste and has some brown seeds. This hybrid is intended for growing in protected areas, low tunnels and in open fields.

Transplant production and planting methods on Kovanović family farm

Production of watermelons from transplants is a usual practice. Although in previous years transplants were also grown by grafting watermelon on a pumpkin, the only way of producing watermelon in this case is from traditional transplants.
Watermelons were sown in containers on March 26 and 27, and three different types of containers were used. Containers were previously filled with substrate (flower soil). After sowing containers were transferred to a greenhouse and watered.
Nutrition reinforcement was applied two times. The first time, some 10 days following the germination, Megagreen was used, which proved as an efficient fertilizer in previous years, especially as a „starter“. The second time mixture Profert Mara + Megagreen was applied a few days before transplanting in order to reduce a shock for the plant and to provide nutrient reserves after transplanting.
Temperature was regulated during the day by opening the door and side opening on the greenhouse, and during the night, if necessary, the greenhouse was heated by gas thermo generator.
After additional soil cultivation by tilling and additional soil levelling by a combination seed harrow, mulch and irrigation pipes were laid.
Watermelons were manually transplanted in two days, April 23 and 24, to previously prepared soil, with mulch and irrigation pipes in place.
In the process of manual transplanting mulch is opened to the extent necessary to successfully plant the transplant in soil. After transplanting, the opening is covered with soil and mulch is repaired, if damaged in the process.Watermelons were planted on 100 cm in-row spacing and 200 cm between-row spacing. Such spacing requires about 70 kg of mulch and

5.000 m of irrigation pipes per hectare. Mulch was produced by Croatian company „MetaloPlast"-Batrina, while drip irrigation pipes were produced by American producer „TORO". Spacing between the holes on pipes was 30 cm, with maximum water flow capacity per hour being 8 l/m^2.

Nurturing and protection of crops was included in all phases of watermelon production. They were conducted according to the envisaged technology of watermelon production, both in transplant production and in field production.

One of the methods of taking care about crops is irrigation. The whole area was irrigated with drip irrigation, which was also used to reinforce nutrition of watermelons.

Irrigation water is usually supplied from a nearby channel or well, and if both possibilities are inaccessible, then water tanks are used. This farm has one tank of 8 m^3 capacity, which, with whole-day irrigation, provides sufficient quantities of water for plants to survive during dry periods, but not sufficient for optimum irrigation. This year water from a nearby channel was used throughout the vegetation period, so that plants had sufficient quantities of water for optimum development.

Table 5: Type, method and quantity of applied chemicals

WEEDS		
FINE LEAVED	RAZZA FOCUS ULTRA	Incorporated in soil 2 l/ha After germination 1 l/ha
BROAD LEAVED	RAZZA	Incorporated in soil 2 l/ha
DISEASES		
POWDERY MILDEW	ANVIL 5-SC	50 ml in 100 l of water
	RUBIGAN EC	0,3 l/ha
DOWNY MILDEW	ANTRACOL WP-70	3kg/ha
	ALIETTE WP	3 kg/ha
	2X RIDOMIL MZ 72	25g in 10 l of water
ANTHRACNOSE	DITHANE M-45	40 ml in 100 l of water
PESTS		
APHIDS	3X DURSBAN E-48	15 ml in 10 l of water
WIREWORMS	DURSBAN G-7,5	20 kg/ha

Due to regular treatment of weeds and pests, there were no larger losses caused by increased weediness or fruit damages caused by pests. In addition to aphids and wireworms, watermelons are usually treated against nematodes and moths, but this year there was no need for such a treatment.

ORGANIZATION AND ECONOMICS OF PRODUCTION

Organization, soil cultivation, fertilization and protection

A projection of standards for utilized machinery was calculated according to the Tables 6 and 7.

Table 6. Soil cultivation machinery standards

Plot length (m)	PLOUGH Distance to the plot (m)			DISK HARROW First time Distance to the plot (m)			DISK HARROW Second time Distance to the plot (m)			COMBINED SEED HARROW Distance to the plot (m)		
	1.000	2.000	3.000	1.000	2.000	3.000	1.000	2.000	3.000	1.000	2.000	3.000
200	1,8	1,8	1,7	5,6	5,4	5,2	7,0	6,7	6,5	8,0	7,7	7,5
300	2,0	1,9	1,8	6,1	5,9	5,7	7,6	7,4	7,1	9,0	8,9	8,3
400	2,1	2,0	1,9	6,4	6,1	5,8	8,0	7,6	7,2	10,4	9,5	8,9

Standards from the Table 6 were calculated based on the following: 15 minutes of machinery maintenance, 12 km/h of average speed from the farm to the plot; 8,5 km/h of average speed during work, and 5 km/h during ploughing.

Table 7: Fertilizer and treatment machinery standards

Plot length (m)	SPREADER Distance to the plot (m)			SPRINKLER Distance to the plot (m)		
	1.000	2.000	3.000	1.000	2.000	3.000
200	9,7	9,3	9,0	4,3	4,2	4,1
300	10,5	10,2	9,8	4,6	4,4	4,3

400	11,0	10,5	9,9	4,9	4,7	4,5

Standards from the Table 7 were calculated based on the following: 15 minutes of spreader maintenance and 30 minutes of sprinkler maintenance; 12 km/h of average speed from the farm to the plot, and 8 km/h of average speed during work.

Organization of watermelon sowing and harvest

Planting of transplants requires two workers working the whole day. Transplanting requires 10 people per hectare on a daily basis. Watermelon harvest is a process requiring experienced workers with years-long experience in order to provide the harvesting of ripe and quality fruits. In addition to finding skilful workers, the problem is also in finding a sufficient number of trailers. One harvest requires over 10 trailers, which are hard to find, and the same applies to labour force. The number of workers during harvest depends on several factors (quantity of watermelons that will be harvested, their size, weather conditions, skills of workers, etc).

Economics of watermelon production

The total production costs, production value and potential loss or gain can be calculated by using the data about costs of inputs, fuel, fertilizers, plant protection, labour force and machinery use, and the data on achieved yields. Exactly such account of costs and realized profit is given in the Table 8.

Economic indicators of production efficiency

Labour productivity represents the ratio of utilized hours per area unit.

$$P = \frac{\text{Q (yield) kg/ha}}{\text{T (h/ha)}} = \frac{\text{40.000 kg/ha}}{\text{372 hours/ha}} = \text{120,5 kg/hour}$$

Production efficiency is calculated based on calculation elements.

$$E = \frac{\text{Production value (kn/ha)}}{} = \frac{\text{4.563,65 EUR}}{} = 1,31$$

Total costs (kn/ha) 3.475,38 EUR

Efficiency exceeding 1,0 represents profit.

Production profitability is expressed in a profitability rate in percentage, and it is calculated as the ratio between realized income and total costs. It shows income in kunas on 100 invested kunas during the production process.

$$R = \frac{\text{Income (kn/ha)} \times 100}{\text{Total costs (kn/ha)}} = \frac{1.088 \text{ EUR/ha} \times 100}{3.475{,}38 \text{ EUR/ha}} = 31{,}3\ \%$$

Table 8: Costs and results of watermelon production on the total area (EUR/ha)

Share (%)	**Item**	**Meas. unit**	**Amount**	**Price (EUR)**	**Amount (EUR)**
6,23	Seed	piecekg	5,7	37,99	216,54
3,73	Mulch		70	1,85	129,5052102,60
2,95	Irrigation pipes	t			412,04
11,86	Mineral fertilizers	t	1,2	343,37	68,27
1,96	Manure	kg	33,3	4,10	129,60
3,73	Kristalon	l	80	1,62	14,14
0,41	Profert Mara	kg	2	7,07	40,76
1,17	Megagreen		2	20,38	622,71
17,92	Plant protection	ha	51	12,12	82,08
2,36	Land holding	ha	1	82,08	54,72
1,57	Insurance	ha	1	54,72	13,68
0,39	Water fee	ha	1	13,68	54,72
1,57	Interests	hour	1	54,72	707,79
20,37	Tractor utilization	hour	44.3	15,98	693,88
19,97	Labour	l	332	2,09	73,03
2,10	Pump fuel		67	1,09	59,32
1,71	Other costs				
100	**TOTAL COSTS**		**ha**	**1**	**3.475,38**
PRODUCTION VALUE					
FIRST HARVEST		t	6,7	164,16	1.099,87
MAIN HARVEST		t	26,7	109,44	2.922,05
LATE HARVEST		t	6,6	82,08	541,73
TOTAL		t	40,0	114,09	**4.563,65**
FINANCIAL RESULT			**ha**	**1**	**1.088,27**

Conclusion

The importance of watermelon production is reflected in employment of seasonal workers, because watermelons are harvested on several occasions. However, the most important thing in watermelon production is that producer earns higher income per area unit, not only in relation to some crops, but also in relation to many vegetables.

Growing on bare soil requires smaller investments in production, but plants are more susceptible to diseases. Excessive growing of weeds can also cause problems. Also, fruits ripen much later, and yield and income are smaller than when other production methods are used. Production on mulch reduces problems with weeds, also moisture is preserved under mulch and intensive irrigation is not needed.

Growing watermelons from transplants is the most intensive production method, resulting in the highest yields. In combination with transplanting on mulch and drip irrigation, it results in a very early and stable yield. Such growing method reduces problems with weeds and plant diseases, fruits are usually cleaner and harvest is made more easily. This production method requires large investments, but the outcome is usually better.

In this case transplants were planted on mulch with drip irrigation. The subject of research of this paper is organization of watermelon production on the area of three hectares. Based on calculated standards and developed technological map, the consumption of 44,3 hours of machine work and 332 hours of human labour per hectare were determined. The total costs amount to €3.475,38, and, with 120 tons of yield and production value of €4.563.65, the realized profit was €1.088,27.

Based on coefficient of economy of 1,31, the conclusion was made that watermelon production is efficient, and every €100 invested in production resulted in €31,3 of profit.

REFERENCES

1. Jurišić M. (2009): AGBASE – Agrotehnika važnijih ratarskih i povrćarskih
2. kultura, VIP projekt MPŠVG-VIP-V-10-9/04., Zagreb.
3. Kanisek J., Jurišić M., Bešlić P. (2001): Organizacija i rentabilnost uzgoja
4. krumpira u Slavoniji, Poljoprivreda Vol.7, Br.2., Osijek.
5. Maceljski M., Cvjetković B., Ostojić Z., Igrc-Barčić J., Pagliarini N., Oštrec
6. Lj., Čizmić I. (1997): Zaštita povrća od štetočinja (štetnika, uzročnika bolesti i korova), Znanje, Zagreb.
7. Matotan Z. (1994): Proizvodnja povrća, Nakladni zavod Globus, Zagreb.
8. *** Glasnik zaštite bilja (2006): Sortiment i proizvodnja presadnica lubenica 6/2006, Zagreb.
9. *** FAO Production Yearbook, Rim, 2005
10. http://faostat.fao.org
11. http://www.colic-trade.com/hydro.php#vodotopivo
12. http://www.vitaflora.hr/hr/ProductProfertMara.html
13. http://croatian.wunderground.com
14. http://aggiehorticulture.tamu.edu/vegetable/watermelon/photo_gallery.html