ECONOMIC EFFECTS OF IRRIGATION IN THE INTEGRAL APPLE PRODUCTION

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Abstract
Apple is the second most abundant fruit species at the territory of the Republic of Serbia, right after plum. Most of the apples are grown in technologically obsolete plantations, whereby the most of plantations have no irrigation systems. Because of this, climatic conditions have great impact on achieved yields and their stability, as well as on gained business results (incomes) at the holdings. According to this, main goal of the paper is to present the economics effects of irrigation applied in apple production at the area of Vojvodina province. In order to determine the economic effects of integral apple production under use of irrigation, in paper were presented calculations based on variable costs concerning the usual apple production, as well as production in modern systems with application of irrigation.
Keywords
apple, irrigation, contribution margin, integral production

Introduction

Apple is the most important deciduous tree. As fresh fruit, it is consumed during entire year. Besides that, its fruits can be used for various types of processing (juice, concentrate, cider, vinegar, etc.). Regarding the production, turnover and consumption of apple, it is placed at the third place, right after citruses and bananas (Nikolić, Fotirić, 2009). As well as the development of all fruit lines, the development of technological process of apple production has a great significance for the development of all accompanying industry branches (production of pesticides, mineral fertilizers, agro-mechanization, packaging and equipment, construction of warehouses and accompanying infrastructure, etc.). Of course, by feedback through the development of the related industries, as well as through the offer of new agro-technical solution, there would be made the concrete impact on modernization and intensification of the apple production, and indirectly to the increase of domestic fruits competitiveness level on the international market (Jeločnik et al., 2011).

Use of irrigation enables the growth and stabilization of achieved income level, in other words it ensures the long-term sustainability of agricultural holding (Subić et al., 2015). Its application provides an increase of production and economic effects, which quantification can be done according to size of irrigated area, level of technical equipment, available labour and market requirements (Potkonjak et al., 2011).

In the paper were analysed and compared two different types of apple production. There is observed the conventional apple plantation, which is not irrigated, as well as other type of production, apple plantation that contains irrigation system and is conducted according to

modern growing method (integral production). According to Miletić and Tamaš (2009), currently is the most actual the integral plant protection, which includes all disposable methods of plant protection. This system is primarily based on the application of agro-technical, mechanical and biological measures. The application of chemical protection came down to a minimum (only in the case of a specific need), so within the chemical measures, it has been used more selective, toxicologically and eco-toxicologically more favourable compounds.

Pome fruit species cover in Serbia over the 20% of the areas under orchards. Growing conditions for mentioned species are mostly favourable. Dominant production regions are the area of Danube river basin, North Bačka region, region of Srem and Šumadija region. The share of pome fruits in the total fruit production is around 25%, what, after comparison with areas under mentioned species, it can drive to conclusion that growing of these fruits in regard to others has a greater intensity. Apple is the most important pome fruit grown in Serbia. They cover the area of 23,737 ha. Concerning the production areas, it is the second fruit species, just after the plum. At the European level, concerning the areas under apple, Serbia is on the 12th place (Keserović et al., 2014).

According to the agricultural Census in 2012, the average apple yield was around 10.7 t/ha, what is negligible in compare to the averages gained in by fruit production more developed European countries. At the same time, this is an indicator of extensiveness of considerable part of plantations (Keserović et al., 2014).

Total areas under the apple and volume of apple production in Serbia, Europe and world within the period 2006-2012 is shown in Table 1.

Table 1 Total production and surfaces under the apple in Serbia, Europe and world (period 2006-2012)

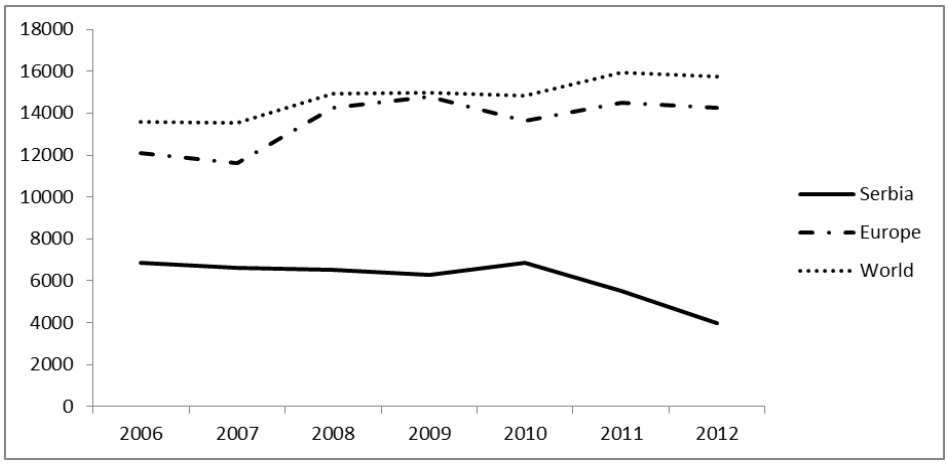
Year	Surfaces (ha)			Production (t)		
	Serbia	Europe	World	Serbia	Europe	World
2006	35,000	1,280,088	4,722,396	240,320	15,478,835	64,221,055
2007	37,000	1,267,202	4,813,675	245,228	14,719,237	65,197,338
2008	36,000	1,074,334	4,619,561	235,601	15,343,802	69,047,694
2009	45,000	1,066,214	4,735,832	281,868	15,768,102	71,000,804
2010	35,000	1,035,572	4,751,202	239,945	14,128,834	70,581,492
2011	48,000	1,048,833	4,782,074	265,576	15,190,055	76,130,690
2012	45,000	1,050,495	4,842,822	178,713	14,970,504	76,378,738

Source: FAO, 2015, web portal FAOSTAT, retrieved at: http://faostat.fao.org/site/567/DesktopDefault.aspx?PageID=567#ancor

Note: Presented surfaces and production of apple in Serbia significantly differ from SORS data, because FAO use different methodological approach in agricultural production elements estimation.

The areas under apple in Serbia, during the analysed period (2006-2012), show a positive trend, so during the last shown year there were 45 thousand hectares under the apple. At the European level, the areas under the apple are constantly decreasing and they were shown pronouncedly negative trend, while at the world level, variation of areas under the apple plantations is minimal. The total apple production at the European and world level varies from year to year, greatly depending from modernization level of available production conditions, or from level of impact of weather conditions to the organized production. Among the analysed regions, the

greatest variation of total production was achieved in Serbia, whereby the lowest production was recorded in 2012.
The yield trend (in t/ha) within the analysed period at the Serbian level was negative, while at the European and world level mentioned trend is positive (Graph 1).



Source: FAO, 2015, web portal FAOSTAT, retrieved at: http://faostat.fao.org/site/567/DesktopDefault.aspx?PageID=567#ancor

Fig. 1 Trend of apple yield in Serbia, Europe and world (period 2006-2012, in t/ha)

According to FAO data, the apple yield in Serbia in 2012 was around 3,971 kg/ha, what is far below the yields achieved at the European level (14,251 kg/ha), or world level (15,772 kg/ha).

Methodology

Data needed for the calculation were obtained from the agricultural holdings at the Vojvodina region that are involved in apple production. Calculations based on the variable costs were made for the area of one hectare, as well as presented in in EUR. Estimation of the production results in the terms of uncertainty was done by the use of critical values (values when contribution margin equals the zero). All gained results were shown by graphs and tables.
Collecting the data for calculation of the contribution margin was done by the survey. In addition, publications, journals and other literature sources, relevant for the topic were used.

Results and discussion

There is small number of agricultural holdings engaged in fruit production, i.e. the apple production that has plantations covered by system for irrigation. So called dry land production system is followed by lower and unstable yields, which primarily depend on the weather conditions (appearance of droughts). However, with introduction of intensive growing system with application of irrigation, significantly higher yields can be achieved, and this is the aim of study, to show the effect of irrigation in apple orchards.
Data needed for calculations are collected at the territory of Vojvodina region, at the full cropping plantations (aged 5-7 years), which belong to the individual agricultural producers. Complex calculation of the contribution margin in apple production at plantations that do not include irrigation system is shown in the Table 2.

Table 2 Contribution margin in apple production (without irrigation)

Description	Quantity	UM	Price (EUR)/UM	Total (EUR/ha)
Income				
Apple (I class) - fresh (60%)	18,900.00	kg	0.45	8,472.41
Apple (II class) - fresh (30%)	9,450.00	kg	0.27	2,525.43
Apple – for industrial processing (10%)	3,150.00	kg	0.16	488.79
PRODUCTION VALUE (PV)	31,500.00	kg	0.36	**11,486.64**
Variable costs				
Seedlings (change)	20.00	pcs	1.25	25.00
Fertilizers				290.52
Chemical protection (pesticides)				469.05
Packing (wood boxes - 15 kg)	2,100.00	pcs	0.60	10.86
Mechanization activities				314.48
Engaged labour				1,817.24
VARIABLE COST (VC)				**2,927.16**
CONTRIBUTION MARGIN: CM = PV - VC				**8,559.48**

Source: According to authors calculations

Gained contribution margin in conventional apple production system is significantly above zero. In the structure of variable costs the biggest share has the labour costs (43.51%). The importance of labour costs participation in the total costs was mentioned by Mamuza and Vaško (2013), who state that the fruit production, especially the production of fruit for fresh consumption, is highly labour intensive, what means that in the production costs the participation of human labour is extremely high.
Critical values gained in apple plantations without irrigation are shown in Table 3.

Table 3 Critical values

Description	EUR(kg)/ha
Expected yield - average (EY)	31,500.00
Expected price – average (EP)	0.36
Subsidies (S)	0.00
Variable costs (VC)	2,927.16
Critical price: KP = (VC - S) / EY	**0.09**
Critical yield: KY = (VC - S) / EP	**8,027.19**
Critical variable costs: CVC = (EY x EP) + S	**11,486.64**

Source: According to authors calculations

Critical values in apple production without irrigation, or values when the contribution margin equals with zero, in mentioned production conditions, are:

- critical price, 0.09 EUR/kg;
- critical yield, 8,027.19 kg/ha;
- critical variable costs, 11,486.64 EUR/ha.

The other type of production refers to apple plantations with system of integral production and application of irrigation system. Necessary data has been collected by interviewing the family agricultural holdings from the territory of Vojvodina region, which are involved in

integral apple production and whose crops are (by the yield), as in previous case, in full productivity.
Contribution margin for the apple production that implies irrigation systems is shown in Table 4.

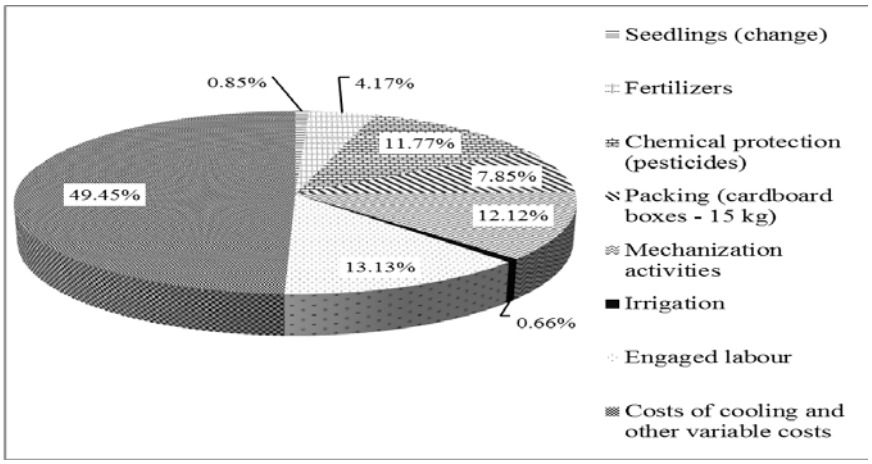
Table 4 Contribution margin in apple production (with irrigation)

Description	Quantity	UM	Price (EUR)/UM	Total (EUR/ha)
Income				
Apple (I class) – from cooler (85%)	59,330.00	kg	0.69	40,917.24
Apple (II class) – from cooler (10%)	6,980.00	kg	0.52	3,610.34
Apple – for industrial processing (5%)	3,490.00	kg	0.13	451.29
PRODUCTION VALUE (PV)	69,800.00	kg	0.64	**44,978.88**
Variable costs				
Seedlings (change)	40.00	pcs	3.79	151.72
Fertilizers				741.85
Chemical protection (pesticides)				2,093.64
Packing (cardboard boxes - 15 kg)	4,654.00	pcs	0.30	1,396.20
Mechanization activities				2,156.39
Irrigation				117.24
Engaged labour				2,336.30
Costs of cooling and other variable costs				8,796.04
VARIABLE COST (VC)				**17,789.39**
CONTRIBUTION MARGIN: CM = PV - VC				**27,189.49**

Source: According to authors calculations

Contribution margin (gross financial result), which is realized in the integral apple production that imply irrigation system, is 27,189.49 EUR/ha, what is much higher than achieved results in the conventional apple production (without irrigation). In the structure of variable costs, the highest participation has the costs of cooling and other variable costs, with the share of 49.45%, while the lowest share has the costs of irrigation (0.66%).

Participation of other variable costs within the total variable costs is shown in the Graph 2.



Source: According to authors calculations

Fig. 2 Structure of variable costs in apple production – integral plantation (with irrigation)

The value of variable costs related to the irrigation system, fee for water usage, as well as fee for the usage of the facilities of Hydro system "Danube-Tisa-Danube", are shown in Table 5.

Table 5 Irrigation

Description	Quantity	UM	Price (EUR)/UM	Total (EUR/ha)
Energy (fuel) and other variable costs of irrigation system				107.00
Fee for water used in irrigation	1,051.00	m^3	0.0010	1.01
Fee for the use of Hydro-system "Danube-Tisa-Danube" facilities for irrigation				9.23
- for installed capacity	1.00	ha	2.78	2.78
- for engaged capacity	1,051.00	1,000 m^3	6.14	6.45
Total				**117.24**

Source: According to authors calculations

Within the irrigation costs structure related to integral apple production, the highest share has the cost of energy (fuel) and other variable costs of irrigation system (91.27%). Then come the share of the fee for the use of Hydro-system "Danube–Tisa–Danube" facilities related to irrigation (7.87%), while the share of fee for the use of water in irrigation is almost negligible (0.86%).

Critical values for integral apple production (that includes irrigation) are shown in Table 6.

Table 6 Critical values

Description	EUR(kg)/ha
Expected yield - average (EY)	69,800.00
Expected price – average (EP)	0.64
Subsidies (S)	0.00
Variable costs (VC)	17,789.39
Critical price: KP = (VC - S) / EY	**0.25**
Critical yield: KY = (VC - S) / EP	**27,606.27**
Critical variable costs: CVC = (EY x EP) + S	**44,978.88**

Source: According to authors calculations

Critical values (at which the contribution margin equals with zero) in the production conditions that include irrigation, have a following values:

- critical price, 0.25 EUR/kg;
- critical yield, 27,606.27 kg/ha;
- critical variable costs, 44,978.88 EUR/ha.

Effects of irrigation that is applied in apple plantation involved in system of integral production are shown in Table 7.

Table 7 Effects of irrigation

Description	Total	
	(EUR/ha)	%
Calculation without irrigation		
PV_0 (Production Value)	11,486.64	
VC_0 (Variable Costs)	4,176.29	
CM_0 [Contribution Margin (PV_0-VC_0)]	**7,310.34**	
Calculation with irrigation		
PV_1 (Production Value)	44,978.88	
VC_1 (Variable Costs)	17,789.39	
CM_1 [Contribution Margin (PV_1-VC_1)]	**27,189.49**	
Calculation of effects of irrigation		
PV_1 - PV_0 = PV_P (Increase of production value)	33,492.24	291.58
PV_1 - VC_0 = VC_P (Increase of variable costs) = Ti (Costs connected to irrigation)	13,613.09	325.96
CM_1 -CM_0 = CM_P (Increase of contribution margin)	**19,879.15**	**271.93**

Source: According to authors calculations

Effect of irrigation is reflected through the increase of the contribution margin for 21,363.55 EUR/ha, which was established as the result production value increase for 35,038.60 EUR/ha, as well as increase of variable costs for 13,675.05 EUR/ha. Implementation of irrigation in apple plantation has been led to a greater increase in variable costs (4.26 times), compared to the increase of production value (3.92 times), but at the same time there was came to the increase of yield per production unit, so that had not significant influence on the established contribution margin, which was increased 3.72 times.

Conclusion

Achieved contribution margin in both production systems leaves enough space for covering of fixed costs and achievement of positive financial result, after variable costs are covered. By introduction of integral production and system of irrigation (in compare to apple plantations without irrigation), it can be achieved the difference in contribution margin values, with increase by 3.72 times.

After implementation of modern production systems, critical price was significantly grown and it amounts 0.25 EUR/kg, while in conventional production it amounts 0.09.EUR/ha. Critical yield in integral production is 24,606.27 kg/ha, and in production that does not contain irrigation, it amounts 8,027.19 kg/ha. The highest increase was gained at critical variable costs, so at modern plantations they amount 44,978.88 EUR/ha, while in conventional production they are 11,486.64 EUR/ha.

Implementation of new production systems with use of systems for irrigation would allow the fading of impact of unfavourable weather conditions, with the goal to increase the apple yield and the holding's business results.

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