ECONOMIC ASPECTS OF APPLE PRODUCTION BY USE OF NEW TECHNOLOGIES

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Abstract
According to data of the Statistical Office of the Republic of Serbia, in 2015. in Serbia there were recorded 23.737 ha under apple plantations. Apples have the perspective in relation to more intensive production, indicating the specific possibilities of apple production development, both from economic and agro-climate aspect. In paper are presented different types of production (conventional, integrated and integrated with application of new technologies) realized in three different areas of the Republic of Serbia (Upper, Central and Lower Danube Region). The economic effects of apple production are shown for the varieties Granny Smith, Jonagold, Braeburn and Gala. Based on the analysis of the effects of new technologies applied in apple plantations, it can be seen that they greatly affect the yield increase, as well as business results of holding.
Keywords:
Apple production, new technologies, economic aspect

Introduction

Apple is one of the most important fruit species in the world, as well as the leading species within the Europe. According to production and consumption, among the all fruit species apple is on third place, just behind citruses and banana. It may be underlined that state of apple production can represent a level of development of entire fruit production within any country, as with the increase in number of apple trees, growth the intensity of fruit production in general (Milić et al., 2005).
Intensification of fruit production is directly influenced by involvement of modern and highly productive systems of apple fruits growing, throughout the realization of next requirements (Veličković et al., 2009):

- Total reduction of habitus (“orchard at the hand”);
- Optimal density of planting – with the increase of apple trees number up to the maximal use of production area;
- Selection of specific pomo-technical interventions for certain systems of growing.

Production of apples that will provide high and stable yields requires the use of all agro-technical measures inherent to its technology, also including the irrigation (Potkonjak et al., 2011).
Modern-intensive apple production provides high incomes per unit of production area, but on the other side, it requires significant investments (Mamuza and Vaško, 2013). The main goal of the organizer of any agricultural production is profit gaining, in other words establishment of each fruit plantation should be economically viable and financially profitable. Just on this way set production systems motivate the intensification of production and increasing of used area at the holding. Unfortunately, currently at the farms of individual producers is still absent specialization, with the

production of number of agricultural products, where achieved total farm profit represents the sum of profits (losses) of all separate production lines (Jeločnik et al., 2011).
Almost all countries of Central and South-east Europe, including Serbia, were felt during the transition period profound consequences caused by for decades inadequately guided development policies within the agricultural sector. Very strong manifestation of these problems are related to the irrational management (environmental pollution, soil degradation, etc.), what despite a relatively low application of inputs left a long-term impacts on natural resources (Oljača et al., 2008).
Considering that apple has expressed need for pesticide treatments, maintaining the safety and quality of produced fruits introduced application of Integrated Production System in practice, involving the methods that reduce usage of pesticides and fertilizers according to ecological, economic and toxicological principles, in order to preserve human health and natural resources (Obradović et al., 2013). Integrated production is based on standards established by Integrated Production Association, representing the transition to a sustainable, i.e. organic production. Up to 85% of the EU fruit production is within the system of Integrated Production. Similar production systems are rapidly developing in Chile, Argentina and South African Republic. European experience in the implementation of Integrated Fruit Production standards, except benefits, also indicate a large number of limiting factors caused by abiotic, biotic and social conditions within which production is carried out. Basically Integrated Fruit Production could be seen as the development of philosophy, general principles and specific agro-techniques for each of fruit species. Developing and implementation of the Integrated Fruit Production concept provides more efficient and sustainable fruit production that is more competitive at the open market, representing the solid support to national income. Integrated and biological concept of fruit production has to be only one and the most important way of preparing our national fruit production for the EU accession (Milić et al., 2012).
Integrated fruit production is pretty much strict and rigid regarding the pesticides control requirements. Yet it should not be identified with organic production. Unlike organic farming, Integrated Fruit Production does not require the elimination of agricultural chemicals usage, but rather great decrease (or even exclusion) of production inputs with high impact on the environment, such as the wide range of pesticides and fertilizers, preferring the application of useful and safe alternatives (Maksimović and Puška, 2015).
Economic motive is the dominant factor while choosing a proper system of fruit production. In other words, if there is no certain amount of profit, producers are not interested in integrated or organic fruit production, regardless any other significant advantages provided by mentioned production (Prodanović and Babović, 2014).

1. Material and working method

The paper objective is a comparative overview of the techno-economic analysis of three different systems of apple production. First one represents the conventional apple production, the second implies integrated production and the third is turned to integrated production of apples with application of new technologies. It should be mentioned that the production results of different varieties are presented, depending on the system of apples growing, as like:

- Granny Smith and Jonagold – conventional system of apple production;
- Granny Smith and Jonagold – integrated apple production;
- Braeburn and Gala – integrated apple production (with application of new technologies).

According to the calculations based on variable costs (contribution margin), in paper was presented the comparison of economic effects among chosen systems of apple production. It should be mentioned that holding's needs for such a calculation model (with elements of production value and costs) arise from its simplicity and easy application, so they are in position

to establish a quick analyze of sustainability of adopted production technology and achieved production results (Subic et al., 2015).
During the process of paper writing, a great number of different literature units related to apple production and assessment of economic effects were consulted. All calculations were based on data obtained from production year 2014/2015. Field data were collected within the area of the Upper, Middle (Metropolitan area) and Lower Danube region. Besides, data from STIPS (Agricultural Market Information System of Serbia) were also used. It has to be mentioned that apples kept in cold storage are selling within the period January-March (they are storing for 3-6 months). One of author's intentions was also to show that the economic effect is much greater if apples are selling after storing in cooler (bringing at the market in the moment of highest price). All calculations of contribution margin were done for the production area of one hectare (ha).
The integrated apple plantation that involves application of new technologies is located at the area of Upper Danube region. Plantation was established under the higher trees density, in order to accelerate return of invested assets. With such a planting density it is possible to enter a period of full yielding at third year of orchard exploitation.
Within the irrigation process at mentioned plantation, a moisture condition of soil is observed each day by tensiometer, determining the norms per one watering cycle and interval between two irrigations. Another advantage of irrigation system is that it is fully automated, so it can be turned on by remote control via computer.
In order to protect plantings from frost in plantation is used water isothermal characteristic, as during its transfer from liquid to solid physical state is released per each gram of frozen water about 334,9 J of heat that protects the bud, flower or fruit embryo from freezing. Therefore, in order to protect all the organs from freezing, in the critical period, whereas temperature is just below 0° C until the termination of critical temperature, flowers or small fruits at the beginning of maturation are sprayed with the water in form of fine mist. Due to the low temperature, in contact with all organs of fruit trees water freezes so quick, forming on the surface protective layer of ice, while the inner tissue due to released heat (80 calories per 1 gram of frozen water) is not affected by freezing. Thereby, temperature growth is in proportion to the amount of water used for spraying.
The system is turning on when outside temperature drops to + 1° C and runs until the formed ice starts to melt. Full automation of system is possible. Working pressure at the nozzles is around 4 bars. By longer spraying and consumption of larger quantities of water may be achieved protection at significantly lower temperature, even at the frosty days with -10° C. Mentioned cannot be achieved by some other ways.

2. Research results and discussion

Three zones within the Danube basin were analysed: area of the Lower, Middle (Metropolitan) and Upper Danube region. In the area of Lower and Middle Danube region at the observed holdings are grown varieties of Granny Smith and Jonagold, while in the Upper Danube region within the system of integrated apple production (with the application of new technologies) are grown varieties of Gala and Braeburn.
In the area of the Lower Danube was analysed apple growing in the system of conventional production with the use of irrigation that includes varieties of Granny Smith and Jonagold (Table 1). Plantation is in period of full yielding, and all entire production is selling at the time of harvest or soon after harvest. Apples are not kept in cold storage, affecting the lower price of apples compared to other areas.

Table 1 Contribution margin in conventional apple production

Description	Quantity	UM	Price per UM (in EUR)	Total (EUR/ha)
Income				
I class (78%)	28.103,40	Kg	0,43	12.084,46
II class (16%)	5.764,80	Kg	0,35	2.017,68
For processing (6%)	2.161,80	Kg	0,09	194,56
PRODUCTION VALUE (PV)	**36.030,00**	**Kg**	**0,40**	**14.296,70**
Variable costs				
Fertilizers				218,20
Pesticides				469,05
Packaging (cardboard boxes – 15 kg)	2.402	Pcs	0,30	720,60
Mechanization				179,30
Irrigation				86,00
Engaged labour				1.250,00
VARIABLE COSTS (VC)				**2.923,15**
CONTRIBUTION MARGIN: CM = PV – VC				**11.373,55**

Source: According to author's calculation based on data of IAE, 2015.

Within the apple production of varieties Granny Smith and Jonagold at the area of Lower Danube region is achieved the contribution margin of around 11.373,55 EUR/ha. Within the structure of variable costs dominates the costs related to engaged labour, around 42,8%. Share of packaging costs are also significant, around 24,7%.

At the area of Middle Danube region, in analysed orchards are also grown apple varieties of Granny Smith and Jonagold (Table 2). Applied production technology is integrated production with the drip irrigation system, and apple plantation is in period of full yielding. Produced apples are storing in cooler.

Table 2 Contribution margin in integrated apple production

Description	Quantity	UM	Price per UM (in EUR)	Total (EUR/ha)
Income				
I class (77%)	53.772,18	Kg	0,7	37.640,53
II class (17%)	11.871,78	Kg	0,53	6.292,04
For processing (6%)	4.190,04	Kg	0,09	377,10
PRODUCTION VALUE (PV)	**69.834,00**	**Kg**	**0,63**	**44.309,67**
Variable costs				
Seedlings (change)	38	Pcs	3,71	140,86
Fertilizers				952,91
Pesticides				2.004,34
Packaging (cardboard boxes – 15 kg)	4.656	Pcs	0,30	1.396,80
Mechanization				2.064,30
Irrigation				112,26
Engaged labour				2.230,00
Costs of cooler and other variable costs				8.422,28
VARIABLE COSTS (VC)				**17.323,75**
CONTRIBUTION MARGIN: CM = PV – VC				**26.985,92**

Source: According to author's calculation based on data of IAE, 2015.

At observed plantations, in the production of mentioned apple varieties was realized the contribution margin of around 26.985,92 EUR/ha. Within the structure of variable costs the highest share has costs of cooling and other variable costs, around 48,6%. Significant share, around 12,9% also have a costs of engaged labour.
The third production system represents integrated plantation with the application of new technologies. It's located at the area of Upper Danube region (Table 3). Involved apple varieties are Gala and Braeburn, and plantation is established under high density of seedlings, in order to accelerate return of invested assets (period of full orchard yielding can starts at the beginning of third year of plantation life).

Table 3 Contribution margin in integrated apple production (with application of new technologies)

Description	**Quantity**	**UM**	**Price per UM (in EUR)**	**Total (EUR/ha)**
Income				
I class (80%)	71.073,60	Kg	0,72	51.172,99
II class (15%)	13.326,30	Kg	0,54	7.196,20
For processing (5%)	4.442,10	Kg	0,09	399,79
PRODUCTION VALUE (PV)	**88.842,00**	**Kg**	**0,66**	**58.768,98**
Variable costs				
Seedlings (change)	49	Pcs	3,84	187,97
Fertilizers				770,00
Pesticides				2.550,00
Packaging (cardboard boxes –15 kg)	5.923	Pcs	0,30	1.776,90
Mechanization				2.627,00
Irrigation				94,40
Engaged labour				2.845,70
Costs of cooler and other variable costs				10.716,00
VARIABLE COSTS (VC)				**21.567,97**
CONTRIBUTION MARGIN: CM = PV – VC				**37.201,01**

Source: According to author's calculation based on data of IAE, 2015.

Contribution margin achieved in the production of apple varieties of Gala and Braeburn in integrated apple production with the application of new technologies was around 37.201,01 EUR/ha. Within the structure of variable costs dominates the costs of cooling and other variable costs, around 49,7%.

In Table 4 is shown the effect of integrated apple production within the area of Middle Danube region compared to conventional production organized in the area of the Lower Danube region. In both cases varieties of Granny Smith and Jonagold were grown.

Table 4 Effects of integrated apple production in relation to conventional production

Description	Total (EUR/ha)	%
Calculation with conventional production		
PV_0/(Production value)	14.296,70	
VC_0/(Variable costs)	2.923,15	
CM_0/[Contribution margin (PV_0-VC_0)]	**11.373,55**	
Calculation with integrated production		
PV_1/(Production value)	44.309,67	
VC_1/(Variable costs)	17.323,75	
CM_1/[Contribution margin (PV_1-VC_1)]	**26.985,92**	
Calculation of effects of integrated production		
$PV_1 - PV_0 = PV_{i}$ /(Increase of production value)	30.012,97	209,93
$VC_1 - VC_0 = VC_{i}$ /(Increase of variable costs) = Tn /(Costs in relation with integrated production)	14.400,60	492,64
$CM_1 - CM_0 = CM_{i}$/(Increase of contribution margin)	**15.612,37**	**137,27**

Effects were reflected throughout the increase of production value for around 30.012,97 EUR/ha, increase of variable costs for around 14.400,60 EUR/ha and contribution margin for around 15.612,37 EUR/ha. In mentioned case established integrated production initiates greater increase in production value than in variable costs.

The effects of implementation of integrated apple production that considers use of new technologies (within the area of Upper Danube region) compared to ordinary system of integrated apple production (within the area of Middle Danube region) are shown in Table 5.

Table 5 Effects of integrated apple production (with application of new technologies) in relation to integrated production

Description	Total (EUR/ha)	%
Calculation with integrated production		
PV_0/(Production value)	44.309,67	
VC_0/(Variable costs)	17.323,75	
CM_0/[Contribution margin (PV_0-VC_0)]	**26.985,92**	
Calculation with integrated production (with application of new technologies)		
PV_1/(Production value)	58.768,98	
VC_1/(Variable costs)	21.567,97	
CM_1/[Contribution margin (PV_1-VC_1)]	**37.201,01**	
Calculation of effects of new technologies introduction		
$PV_1 - PV_0 = PV_{i}$ /(Increase of production value)	14.459,31	32,63
$VC_1 - VC_0 = VC_{i}$ /(Increase of variable costs) = Tn /(Costs in relation with integrated production with use of new technologies)	4.244,22	24,50
$CM_1 - CM_0 = CM_{i}$/(Increase of contribution margin)	**10.215,09**	**37,85**

Implementation of new technologies within the system of integrated apple production initiates the increase in production value for around 1,33 times, then increase in variable costs for around 1,24 times and increase of contribution margin for around 1,38 times.

In Table 6 are shown the effects that can be achieved by use of integrated apple production with the application of new technologies (within the area of Upper Danube region) instead of conventional apple production organized at area of Lower Danube region.

Table 6 Effects of integrated apple production (with application of new technologies) in relation to conventional production

Description	Total	
	(EUR/ha)	%
Calculation with conventional production		
PV0/(Production value)	14.296,70	
VC0/(Variable costs)	2.923,15	
CM0/[Contribution margin (PV0-VC0)]	**11.373,55**	
Calculation with integrated production (with application of new technologies)		
PV1/(Production value)	58.768,98	
VC1/(Variable costs)	21.567,97	
CM1/[Contribution margin (VP1-VT1)]	**37.201,01**	
Calculation of effects of integrated apple production (with application of new technologies)		
PV1 – PV0 = PVi /(Increase of production value)	44.472,28	311,07
VC1 – VC0 = VCi /(Increase of variable costs) = Tn /(Costs in relation with integrated production with use of new technologies)	18.644,82	637,83
CM1 – CM0 = CMi/(Increase of contribution margin)	**25.827,45**	**227,08**

By the application of new technologies in integrated apple production in compare to conventional apple production it can be achieved increase in production value for around 44.472,28 EUR/ha (for more than 4 times), as well as increase in variable costs for around 18.644,82 EUR/ha (for more than 7 times) and increase in contribution margin for around 25.827,45 EUR/ha (for more than 3 times).

Conclusion

In paper were analysed achieved results in systems of conventional, integrated and integrated apple production (varieties of Granny Smith, Jonagold, Gala and Braeburn) with the use of new technologies. Next conclusions could be derived:

- The highest contribution margin was achieved in integrated apple production with the application of new technologies (varieties Gala and Braeburn),
- The largest gap of achieved production value, production costs and contribution margin was realized between integrated production with the application of new technologies and conventional apple production.

Use of new technologies in integrated apple production (tensiometers and anti-frost system) contributes the higher yields and business results. Selected systems and varieties better demonstrate economic effects, suggesting the producers to redirect establishment of new plantations towards more profitable varieties and production system.

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