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ECONOMIC ANALYSIS OF INTEGRATED AND ORGANIC FRUIT PRODUCTION
EKONOMSKA ANALIZA INTEGRALNE I ORGANSKE PROIZVODNJE VOĆA

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ABSTRACT

The introduction of environmentally friendly systems of fruit growing basically entails the conversion of intensive production to alternative production, which is much better for the environment. The optimal economic indicators are achieved in the integrated apple production. Therefore, high investments of labour and materials in this production enable very high production and economic results. High yields per unit area (exceeding 50 t/ha), which are achieved in the integrated apple production, can cover high investments per unit area. The maximum amount of variable costs (854,560 RSD/ha), the highest value of production (3,133,125 RSD/ha) and the gross margin (2,278,565 RSD/ha) have had a positive impact on achieving the highest efficiency (the cost-effectiveness ratio 3.12) in integrated production. On the other hand, this production has showed the lowest cost price per product unit (14.11 RSD/kg), which ensures significant competitiveness in apple production.

Key words: *economic analysis, integrated and organic farming, apple.*

REZIME

Uvođenjem ekološko prihvatljivih sistema voćarske proizvodnje, ustvari se vrši preorijentacija sa intenzivne proizvodnje na alternativne načine proizvodnje, koji su mnogo povoljniji po životnu sredinu. Najpovoljniji ekonomski pokazatelji se postižu u integralnoj proizvodnji jabuke. Naime u ovoj proizvodnji se sa visokim ulaganjem rada i materijala postižu veoma visoki proizvodno-ekonomski rezultati. Visoki prinosi po jedinici površine (i preko 50 t/ha) koji se postižu u integralnoj proizvodnji jabuke mogu da pokriju i visoka ulaganja po jedinici površine. Najveći iznos varijabilnih troškova (854.560 d/ha), najveća vrednost proizvodnje (3.133.125 d/ha) i bruto marže (2.278.565 d/ ha) imali su pozitivnog uticaja na postizanje najveće ekonomičnosti (koeficijent ekonomičnost 3,12) u integralnoj proizvodnji. Sa druge strane, u ovoj proizvodnji je ostvarena i najniža cena koštanja po jedinici proizvoda (14,11 d/kg), koja obezbeđuje značajnu konkurentnost u proizvodnji jabuke.

Ključne reči: *ekonomska analiza, integralna i organska proizvodnja, jabuka .*

INTRODUCTION

Contemporary agricultural production, based on machinery, chemical and other specialised technologies, is perceived as conventional agriculture (*Milić and Sredojević, 2004).* The increased intensity of agricultural production (due primarily to applied chemical technology) has caused environmental pollution, deterioration of food quality, and endangerment of both human and animal life. Therefore, mankind has to face the issue of producing sufficient amounts of high-quality food without harmful effects on the environment. The solutions are sought after in different means of plant and animal production which are usually called in practice 'alternative', 'organic', 'biological' or 'ecological' agriculture *(Lazić and Babović, 2008).*

The development intensity of future agricultural systems will depend on the latest knowledge, the application of scientific results, and the awareness of the fact that production of sufficient amounts of food implies quality standards, as well as production processes which are not harmful to the environment. The scientific and technological development should enable gradual conversion to controlled conventional production, and further development of integrated production and alternative systems, as well as sustainable agriculture. *Princzinger et al., (2004)* state that developed European countries show great demand for high-quality food and raw materials. The application of fertilisers and pesticides requires great care. It should be stated that both fertilisers and plant protection agents are essentially useful in production, provided they are chosen and applied properly and the harvest is done after the withholding period. Nevertheless, the philosophy of their application should be changed. The system of industrial production has been substituted by controlled production (ISO 14.000), which has been further substituted by integrated production. Consequently, profitable agricultural production should entail the use of optimal amounts of fertilizers and pesticides with maximum protection of the producer and the environment. The integrated plant production comprises all the elements of conventional plant production systems but chemical protection agents are recommended only when all the other means of disease, pest and weed control have been exhausted. In addition to agricultural measures within the system of integrated farming, it is important to state that biological measures, weather report and forecast service, integrated plant protection, etc. are also exceptionally important *(Molnar, 2004).* Having considered all the latest trends in environmental protection and increasing demands for food production with low application of synthetic and chemical agents, the concept of integrated production has become a topical issue. This concept is based upon the application of genetic, agronomic, biotechnical and chemical methods in a cost-effective system of production which enables high-quality produce and environmental preservation. The integrated production basically entails a compromise between consumers' demand for safe food and environmental protection, and producers' objectives of establishing a cost-effective and sustainable production. According to *Sredojević (2002)*, organic agricultural production consists of a system which forbids and excludes the application of synthetic fertilisers, pesticides, growth regulators, and feed additives. This production is greatly dependent on crop rotation, plant residues, manure, green manure, and biological weed, disease and pest control. On a business or farm level, the following paradigm should be valid: maximising company's

profit and overall economic results is allowed only under optimal ecological conditions. The goal of organic agriculture is enhancing the health and productivity of mutually co-dependent societies (soil, plants, animals and humans). The basic constituent of this system of food production is the exclusion of synthetic agents and the application of natural materials, which are used to supplant fertilisers, pesticides and additives in food production and processing. The key principle of organic food production is the interaction of all natural components included in the production cycle of safe food, as well as the maintenance and enhancement of long-term soil fertility, the promotion of beneficial and rational agricultural, technical and technological measures, and the protection of life, soil, air, and water. Organic agriculture acknowledges the achievements of conventional agriculture but it harbours a different production concept which is a part of contemporary agricultural production. Therefore, the main objective of this paper (in addition to the theoretical review of basic principles of integrated and organic fruit production) is to analyse the economic justification and the comparison of indicators of fruit production in different production systems, i.e. conventional, integrated, and organic apple production.

MATERIAL AND METHOD

Although the experience in integrated and organic production in Serbia is somewhat insufficient, certain attempts of mastering this production, in both agriculture as a whole and fruit production especially, have been made lately. The data used in the research were obtained from the internal documentation and accounting reports of two apple producers in Vojvodina. The data on the organic apple production were individually projected, that is assumed. The calculation methods of cost price assessment, the variable and differential cost calculation, and the comparative analysis of the obtained economic indicators were used in the research.

RESULTS AND DISCUSION

Integrated Fruit Production

In the European Union, up to 85% of fruit production is within the system of Integrated Fruit Production (IFP), and similar systems have rapidly been developed in Chile, Argentina, and the Republic of South Africa. European experiences in the implementation of IFP standards indicate a large number of limiting factors, as well as advantages which are due to abiotic, biotic and social conditions of production. Basically, IFP involves development of philosophy, general principles, and specific agricultural engineering according to fruit varieties. The development and implementation of IFP concept enables more productive and sustainable fruit production, which is more competitive on open markets and forms a base of the national income. The integrated and biological concept of fruit production is the only and the most important way of preparing our fruit growing for the EU integration.

Integrated fruit production provides high-quality fruits, and the whole process of orchard planting and using favours ecological aspects of fruit production. This type of fruit production is based on strictly controlled scientific and ecological principles, which protect the nature from pollution, offer healthy products to consumers, and enable cost-effective investments on farms. However, contemporary integrated fruit production requires significantly more knowledge of equipment for pesticide application, plant diagnosis, successful growing technology, as well as marketing and management systems in fruit production.

According to *Ćejvanović (2007)*, some of the conditions and principles of integrated fruit production go as follows:

– Professional improvement of fruit producers and their awareness of environmental conservation because fruit producers ought to have a positive attitude towards environmental conservation and human health;
– Orchard location, soil type, fruit varieties and planting systems indicate that producers should avoid frost-susceptible soils, poorly drained and shallow soils, as well as soils with low water holding capacity;
– Soil maintenance and orchard nutrition should preserve the structure, fertility, fauna and microflora of the soil, and nutrients should be obtained, if possible, from the recycled organic matter and humus;
– Maintenance of the inter-row spacing should involve grasses which are not competitive with the fruit, while intra-row spacing should be cultivated in strips (mechanically or by using herbicides);
– Soil should not be irrigated excessively due to nutrient washout, root asphyxiation, water waste and small fruit size;
– Growth patterns should maintain a balance between the vegetative and generative growth, and the light and pesticide infiltration without the use of agents;
– Maintenance of regular yield is obtained by manual fruit thinning or by means of chemical agents based on the Gibberellic or 1-Naphthaleneacetic acid (GA and NAA);
– Integrated protection allows only the use of approved pesticides which do not harm fruit and soil organisms;
– Use of IT and other modern equipment for timely insect, fungi and weed control (weather station for integrated fruit production).

Therefore, integrated fruit production (IFP) is basically a cost-effective high-quality production which favours the safest ecological methods with minimised undesirable effects and chemical agents for environmental and human health protection. In order to achieve this, production technology has to increase the stability of fruit plantations, trees and crops.

According to the expert recommendation (*Gordana Đurić at al., 2005*), integrated production is a high-quality production which gives priority to ecologically sound growing and tends to minimise the use of synthetic chemical agents in order to increase the human safety and health, as well as environmental protection. This production is based on techniques (biological, genetic, agricultural, and phytopathological, etc.) which enhance the balance on farms and increase product quality. Therefore, the application of this protocol demands participation of experts, who would ensure the application of the best growing technique. The protocol is revised annually and adjusted according to the gained experience in production, market demand, new varieties and technical innovations. According to the protocol, the technology of the integrated apple production involves:

1. Growth pattern and planting density – a fusiform growth pattern is recommended (slender and bent spindle) with planting density from 1,950 to 4,000 plants/ha.

2. Pruning – non-productive zones within the tree canopy should be controlled, as well as the ageing of fruit-yielding wood. Green pruning is recommended at the end of May and the beginning of June.

3. Pollination and breeding – if pollinator varieties are planted as separate trees in rows of main varieties they should account for 10-15% of the total tree number. Wherever possible, 3 or 4 beehives per hectare should be emplaced. In order to enhance bee pollination, mowing of the flowering grass cover is recommended. The use of growth regulators is allowed only under special circumstances such as spring frost damages or unfavorable climatic conditions for pollination and breeding.

4. Fruit thinning is applied in order to avoid additional yield, as well as for production of the fruit of desirable size and organoleptic properties. The use of chemical agents contributes to high yield although manual thinning is necessary during high-yielding seasons, usually in the middle of July. Moreover, the use of *6-Benzyladenine* is recommended for standard clones and spurs of the Golden Delicious cultivar.

5. Nutrition plan is based on the results of physical and chemical soil analyses. It is necessary to conduct preliminary soil analyses for each plantation in homogenous area. These analyses have to be repeated every five years. The following parameters are checked in each analysis: soil structure, organic matter, pH value, micro and macro elements, and soil infiltration rate.

When fertilising prior to planting, it is recommended to use 40-60 t/ha of ripe manure, 300 kg/ha P_2O_5 and 450 kg/ha K_2O. Nitrogen fertilizers should not be applied before planting.

The fertilisation during planting involves adding fertilisers along rows (in furrows or every planting spot). In order to reduce the washout risk to a minimum, nitrogen should be added repeatedly, but never exceeding 40-60 kg/ha.

The fertilisation during the maximum yield involves the adding of organic matter, manure, or organic fertilisers in order to increase soil nutrition, enhance soil structure and reduce soil exhaustion. The necessary amount of apple fertilisation should be determined based on the foliar analysis.

The foliar treatment with calcium salts is allowed in order to increase fruit quality (reducing bitter pit incidence, increasing epidermis firmness, etc.). In order to reduce fruit russet, it is allowed to apply kaolin and products based on the Gibberellic acid.

6. Irrigation should be conducted continuously from the beginning of vegetation to the end of September depending on weather conditions and plant moisture requirement (special care should be provided to plants within the period of fruit growing and ripening, as well as after harvest when the differentiation of flower buds is done). The method of drip irrigation is recommended.

7. Integrated protection is practically based on expert advice. It is necessary to strike a balance between indicators and means of protection prescribed in the manual for integrated apple protection.

8. Harvest is the key element of the production cycle and it greatly affects the fruit quality and taste. Harvest time can be determined by different methods (according to the number of days from full blossoming to maturing, the temperature sum, etc.) although most use maturity indices. The iodine test, the change of epidermis colour and sometimes firmness, the dry matter content and the acid content are the most frequently used parameters in apples. In order to obtain fruits with the best organoleptic properties, repeated harvest is recommended. During the harvest, measures for preventing fruit damage ought to be taken (harvesting, storing in crates, transporting). If needed, small doses of apple stop-drop sprays are allowed (NAA).

Organic fruit production

Basic standards for organic production were set by the International Federation of Organic Agriculture Movements (IFOAM) in 1972. This has been a strong incentive for the development of organic agriculture in many countries around the world even prior to adopting national rules and standards.

The technical and technological development of societies influenced the development of agricultural, i.e. fruit production, which strived to achieve higher yield per unit area, larger fruits and better organoleptic properties of the fruit. The intensification of fruit production caused the reduction of the biological value of fruits as food, thus causing its 'biological defectiveness' *(Mratinić, 2005)*. Biological defectiveness of fruits as food is primarily caused by excessive fertilizing (mineral fertilizers), irrigation and preference of less resistant varieties towards diseases and pests, which require the application of great amounts of chemical agents (pesticides, fungicides, insecticides, etc.). In contrast with conventional fruit production which intensively uses chemical technology (artificial synthetic agents produced in chemical industry), organic fruit production is based on natural resources (organic and natural fertilisers, and measures of protection), genetic potential of fruit varieties, and permanent production control.

Organic fruit production is a contemporary development concept of fruit growing which basically combines traditional production with the latest knowledge in fruit genetics, selection, nutrition, protection and preserving without the use of synthetic fertilisers and protective means. The distinctive feature of organic fruit production is a complete prohibition of chemical protective agents and the use of biological means of disease and pest control. Therefore, this principle of fruit growing shows real potential in Serbia (considering the resources) but with a systematic and organised approach. In addition to the technological organisation of this concept regarding different varieties, special attention should be paid to organic varieties and the development of control service with proper certification procedure.

Regardless of the type of growing (conventional, integrated or biological), fruit varieties require optimal ecological conditions for growth and yield, that is, ecological conditions determine species and varieties (Milić *et al.*, 2009). Therefore, it is very important to eliminate the risk when choosing the fruit variety for specific agroecological conditions (knowing that fruit plants are perennial). When choosing the micro-location for this production the following should be considered: climatic conditions (precipitation, low winter temperatures, late spring frosts, air humidity, hail frequency, wind rose, etc.), soil type (depth, nutrients available to plants, texture), soil gradient and exposition, water regime (ground water height, irrigation potential, water holding capacity), infrastructure from the ecological viewpoint (wind, erosion, biotope, and water protection).

Economic analysis of apples in conventional, integrated and organic production

The apple is one of the most important fruits in the world and the leading fruit in Europe. The production and consumption of apples is in the third place within the total fruit production, following citrus fruits and bananas. The apple is an indicator of fruit production in any country because the increase of the apple tree number affects the increase of fruit production intensity, and vice versa. Apples are grown for their pleasant taste, relatively high nutritive value, as well as high vitamin and mineral content. In addition to the consumption of fresh apples throughout the year (apples are very suitable for storing), processed apples are used in juices, brandies, marmalades, compotes, vinegars, etc. Apples have significant nutritive value because they are rich in glucose and fructose, which provide 2400 kJ/kg of energy. They have a very low fat content so they are included in diet foods.

The comparative analysis of main economic parameters should enable a more reliable assessment of different ways of production. It is necessary to make a clear conclusion about the cost-effectiveness of apple production in different systems of production. Based on the empirical data of experts and the data

obtained from the apple production documentation in Čelarevo 2011, starting parameters were set for different types of production, and then the calculation of final indicators was performed (Table 1).

Parameters according to different types of apple production:

1. Conventional production?

1. *Mineral fertilisers* (Urea, N fertilisers, 800 kg/ ha x 45 RSD/kg) 36,000 RSD/ha; 2. *Manure* (10 t/ha) 14,000 RSD/ha; 3. *Protective agents* 182,000 RSD/ha; 4. *Other materials* 148,500 RSD/ha (Packaging – 1,700 apple crates (20 kg) at 85 RSD per piece = 144,500 RSD/ha; Binding material 4,000 RSD/ha); A. *Material costs* (1-4) 380,500 RSD/ha; 5. *Direct services*: tractor work + motor oil and lubricants 110,393 RSD/ha; 6. *Labour costs* 160,300 RSD/ha; B. *Variable costs* (1-6) 651,193 RSD/ha; C. *Production value* (34,000 kg/ha x 40 RSD/kg) 1,360,000 RSD/ha; D. *Gross margin (C-B)* 708,807 *RSD/ha*; 7. *Fixed costs*=15% of variable costs 97,679 RSD/ha; 8. *Total costs* (B+7) 748,872; *Cost price* (8: yield kg/ ha) 748,872 RSD/ha: 34,000 kg/ha =22.03 RSD/kg; *Production cost-effectiveness* (C/8) 1.82.

2. Integrated production

1. *Mineral fertilisers* (Liquid and foliar fertilisers, 85 kg (l) x 485 RSD/kg (l), 41,225 RSD/ha) 41,225 RSD/ha; 2. *Protective agents* (pesticides + chemical thinning agents 115 x 1,440 RSD/kg (l)) 165,600 RSD/ha; 3. *Other materials* – grass mixtures (8,5kg/ha x 400 RSD/kg) 3,400 RSD/ha; A. *Material costs* (1-3) 210,227 RSD/ha; 4. *Direct services*: tractor work + motor oil and lubricants 205,227RSD/ha; 5. *Labour costs* (fixed and seasonal) 439,106 RSD; B. *Variable costs* (1-5) 854,560 RSD; C. *Production value* (69,625kg/ha x 45 RSD/kg) 3,133,125 RSD/ha; D. *Gross margin (C-B)* 2,278,565 *RSD/ha*; 6. *Fixed costs*=15% of variable costs 128,184 RSD/ha; 7. *Total costs* (B+6) 982,744 RSD; *Cost price* (7: yield kg/ ha) 982,744 RSD/ha: 69,625 kg/ha =14.11 RSD/kg; *Production cost-effectiveness* Production value/Production costs=3.12.

3. Organic production

1. *Mineral fertilisers* 0 RSD; 2. *Manure* (40 t/ha) 56,000 RSD/ha; 3. Organic *protective agents* 10,000 RSD/ha; 4. *Other materials* 103,875 RSD/ha; (Packaging – 1,175 apple crates (20kg) at 85 RSD per piece = 99,875 RSD/ha; Binding material 4,000 RSD/ha); A. *Material costs* (1-4) 169,875 RSD/ha; 5. *Direct services*: tractor work + motor oil and lubricants 143,659 RSD/ha; 6. *Labour costs* 219,553 RSD/ha; B. *Variable costs* (1-6) 533,087 RSD/ha; C. *Production value* (23,500kg/ha x 60 RSD/kg, subsidies14, 000 RSD/ha) 1,424,000 RSD/ha; D. *Gross margin (C-B) 890,913 RSD/ha*; 7. *Fixed costs*=79,963 RSD/ha; 8. *Total costs* (B+7) 613,050; *Cost price* (8: yield kg/ ha) 613,050 RSD/ha: 23,500 kg/ha =26, 08 RSD/kg; *Production cost-effectiveness* (C/8) 1,410,000/613,050=2.30

Table 1. The comparative analysis of economic indicators in different types of apple production per hectare

Indicator		Production Type		
		Conventional	*Integrated*	*Organic*
A.	Material costs	380,500 RSD/ha	210,227 RSD/ha	169,875 RSD/ha
B.	Variable costs	651,193 RSD/ha	854,560 RSD/ha	533,087 RSD/ha
C.	Production value	1,360,000 RSD/ha	3,133,125 RSD/ha	1,424,000 RSD/ha
D.	Gross margin (C–B)	708,807 RSD/ha	2,278,565 RSD/ha	890,913 RSD/ha
E.	Fixed costs -15% of variable costs	97,679 RSD/ha	128,184 RSD/ha	79,963 RSD/ha
F.	Total cost (B+E)	748,872 RSD/ha	982,744 RSD/ha	613,050 RSD/ha
G.	Cost price (F/yield per ha)	22.03 RSD/kg	14.11 RSD/ kg	26.08 RSD/kg
H.	Production Cost-effectiveness (C/F)	1.82	3.12	2.32

Variable costs are the costs which change due to production volume, that is, the use of means of production. Variable costs arise from the consumption of production material, i.e. the costs of seed, fertilizers, protective agents, fuel, raw material, and labour. Regarding the level of production intensity, the highest investment of variable factors per unit area is noted in integrated production (854, 560 RSD/ha), and the lowest in organic apple production (553, 087 RSD/ha).

Production value is the market value of farm products and services during one business year. In practice, any production is cost-effective if total costs are lower than total gains. The realised gain (production value) is obtained from the realised yield and sales price, but it should be noted that there is another element of the equation categorised as 'other', which in developed countries refers to state funding of production. The highest production value was determined in the integrated system of production, wherein the highest yield per capacity unit was achieved. The lowest production value was in the conventional apple production (1,360,000 RSD/ha) considering that high investments per unit area do not often affect the realised yield.

It is necessary to state that organic fruits achieve 20-100% higher sales price in comparison with conventional fruits, which makes organic production cost-effective. Higher prices of organic products are main reasons why producers are willing to face financial hardships and the costs of certification, the costs of investment in organic production, and inevitable lower yields during the first years of conversion from conventional to organic production.

The result of converting to organic (ecological) production, based on total exclusion or significant reduction of chemical agents, is a notable decrease in financial results. Therefore, there is a confrontation between ecological demands for environmental preservation and economic interests of agricultural producers, which has been confirmed in practice. Gross margin, as one of economic indicators, is increasingly used in farm business analysis *(Ivkov et al., 2008)*. Gross margin shows how much a farm earns in excess of production costs. On one hand, it shows how much money a farm keeps, and on the other, the share of production costs in revenues.

Contribution margin (gross margin, net income, marginal result) is a very useful success indicator from the viewpoint of short-term decision making (one reproductive cycle in agriculture). Considering that fixed costs are rather unchangeable during a short period, production cost-effectiveness can be more successfully determined by gross margin than net results (gains/losses). The highest gross margin was obtained in the integrated apple production (2,278,565 RSD/ha) due to the highest production value.

The cost price per product unit strikes a balance between total production costs and number of products. The lowest cost price was obtained in integrated production (14.11 RSD/kg) because high yield per unit area was sufficient to cover high production costs.

Production cost-effectiveness is a relative success indicator because it is expressed as a coefficient or percentage. The cost-effectiveness coefficient is obtained from the realized production value and total costs. It shows the realised production value per one RSD of costs. As expected, the highest production cost-effectiveness was obtained in integrated production (the

cost-effectiveness coefficient 3.12), and the lowest in the conventional apple production (the cost-effectiveness coefficient 1.82).

CONCLUSION

Contemporary fruit production is increasingly becoming a technological process in controlled settings independent of climatic and biological processes. It is possible to enhance the orchard productivity and sustainability, and reduce negative effects on the environment and endemic organisms. Alternative solutions make the production less dependent on agrochemical agents and fossil fuels. The extent of their implementation will depend on those who manage the production. Therefore, it is very important to heighten the production managers' awareness of sustainable fruit production. Organic fruit production can be economically justified because lower costs per unit area are obtainable, as well as higher sales prices, which precondition cost-effectiveness. Therefore, organic fruit production is recommendable even without the state aid. One of the important elements of organic fruit production cost-effectiveness is higher average fruit price on global market, which is more than 50% higher than the average fruit price in conventional production. The obtained results for apple production indicate the most favourable economic indicators in integrated production. Therefore, in addition to high labour and material investments, high production and economic results are obtained in integrated production. High yield per unit area (exceeding 50 t/h in the integrated apple production) can cover high investments and make significantly positive financial results. The highest variable costs (854,560 RSD/ha), the highest production value (3,133,125 RSD/ha) and the highest gross margin (2,278,565 RSD/ha) positively influenced the highest cost-effectiveness (the cost-effectiveness coefficient 3.12) in integrated production. On the other hand, the lowest cost price per product unit (14.11 RSD/kg) was obtained in this type of production, which ensures notable competitiveness in apple production.

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