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ECONOMIC OPTIMIZATION OF THE APPLE INVESTMENT AND GROWING SYSTEM ALTERNATIVES IN REPUBLIC OF MACEDONIA

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Abstract

Apple, among all fruits production, has traditional importance and contribution to the Macedonian economy. The favour agro-climatic conditions, combined with the long-lasting tradition, generated human capacity and expert knowledge offer huge potential for growing apples and development of this economic branch. The apple production in Republic of Macedonia is insufficient and uncompetitive on domestic and foreign markets as result of insignificant intensity of the growing system, poor productivity and high production and investment costs.

In order to identify the optimum investment and supreme apple growing system alternative, the economic optimization analysis were performed. For the purposes of this analysis, a field study has been conducted on 39 apple producing farms in the Pelagonia region for the production years of 2009 and 2010. Additionally, the production information are updated with data for the years 2011, 2012 and 2013 based on rapid research, semi-structured interview with the main stakeholders in supply chain and official statistics.

The investment calculations have been used to determine the comparative advantages of the investment in different growing system models. The economic justification to invest in the different growing system was assessed based on the standard indicators for investment evaluation as: internal rate of return, net present value and payback period. The findings show that economic performance of the apple farming depends on the apple growing system. Although, the highly intensive method of apple growing require much higher investment costs, it brings better results than the dominant extensive growing method with low plant density.

Key words: *apple, economic optimization, growing systems*.

Introduction

Fruit production has great significance in our Macedonian economy, as perceived by: share of 12% of the total value of agricultural production (SSO, 2008-2012), engagement of approximately 7,000 agricultural households and agricultural enterprises, 6,730,849 apple fruit trees, utilization of land area 7,742 ha (SSO, 2013), providing of row material to processing facilities and exports of fresh or processed fruits. Despite the favourable environmental conditions and potential for growing of many fruit species in Macedonia, the fruit production doesn’t take its rightful place and is not represented in sufficient measure. According to the last official statistical data for 2013, orchards covered area of 15,000 ha, which constitutes only 3% of total cultivated land.

Apple production dominates the fruit farming sector in Macedonia, with the highest share of 44.7% in the orchards structure (SSO, 2013) and nearly 60% of total fruit production. In the period from 2009 to 2013, the apple production on average is 118,478 tons, reaching a pick in 2012 with 127,171 tones. Apple is a net exported product with a positive ratio of foreign trade balance in favour of exports, accounting for more than 99% compared to imports (SSO, www). The export value of apples is in average 8.5 million US$, varies between 8.6 million US$ in 2009 up to 21.6 million US$ in 2012.

The highest concentration of apple plantations is in the region of the great lakes, 700 m above sea level, located in the geographical regions of Pelagonia and South-West (officially determined by the State Statistical Office), which takes around 79% of the total area with apple orchards in the country (SSO, Agricultural Census, 2007). The individual sector holds in possession 94% of the total area planted with apple orchards, while only 6% belongs to companies.

The focus of this study is the production of apples in the Pelagionia region which takes up to 67% of all apple production area, mainly located in Resen (2,567 ha apple orchards) and Bitola (135 ha apple orchards) municipalities.

The most typically growing systems in the country are characterized with insignificant (minor) density, using more vigorous rootstocks, the trees are higher, the crowns are denser, less in lighted, with a late full fruiting and reduced sunshine. The yields are unsatisfactory undersized and the fruits less coloured (AgBiz programme, 2009). As rootstocks, mostly are used MM106, MM104, MM111, MM109, M26, what give intermediate or high lush trees, with a density of 800 to 1,200 trees/ha. In recent years, although very moderately, can be noticed replacement of apple growing system with using of M9 as a rootstock, with density of 2,500 to 3,000 seedlings per hectare.

The growing system of apple and density of trees is of a huge importance for the fruiting and annual achieved yields. In accordance to Polish researchers, Kierczyńska and Wawrzyniak, three different types of apple (growing systems) orchards are recognized referring to the planting density: traditional or extensive (less than 1,000 trees/ha), intensive (1,000 to 2,000 trees/ha) and highly intensive (more than 2,000 trees/ha).

The aim of this paper is to conduct a comparative investment analysis of tree density impacts on the growing systems performance, on orchards managed by the individual apple producers in the Pelagiona region, as the biggest apple production region in the Republic of Macedonia.

Materials and methods

The research is based on primary and secondary source of data. The target group are the individual agricultural holdings (family farms), which according to the Agricultural Census data has the ownership under 94% of the apple orchards. The survey refers to the five years period from 2009 till 2013 encompassing data from 39 individual agricultural holdings from Pelagonia region. Field survey was conducted by using of specially developed questionnaire for collection of data. In addition, rapid assessment was performed on the field and many farmers were additionally interviewed with an extra set of questions mainly covering the issues of farms assets and investments. Following the initial data processing, panel discussions and semi-structured group interviews were performed with main stakeholders in the apple supply chain as: apple producers, researchers, processors, producers of plant material, advisors and extension agents. Apart from field survey, the researchers use secondary source of data, mainly from official statistics and previous studies.

Investment calculations were used in order to assess the economic viability of investments in different growing systems for apple orchards. The assessment of the economic viability in investment was performed based on the standard investment feasibility assessment indicators as net present value, the internal rate of return and the payback period.

The net present value was calculated based on the future value of annual cash flows discounted at the present time. The net present value is the calculation of the money value, taking in the consideration the time. Actually, the net present value calculates the present value of the money from the future period, taking in the consideration time and inflation.

$$PV_n = \frac{(I - VC - T)}{(1 + i)^n}$$

$NPV = PV_1 + PV_2 + .. + PV_n$

I – income
VC – variable costs
T - taxes
n – period (year)
i – interest rate (discount factor)
PV – present (discounted) value
NPV – Net Present Value

In the analyses, exploiting period of 30 years for the extensive, 25 years for intensive and 18 years for highly intensive growing systems were used. The discount factor was valued at 6%.

Internal rate of return is an indicator of investment efficiency and represents the interest rate of the investment. The internal rate of return is interest rate for which the net present value is zero.

Payback period is the period of time needed to recoup the investment.

$$PP = \frac{IV}{(I - VC - T)}$$

PP – payback period
IV – investment value

The investment value is calculated as sum of initial investment and variable costs of production in the first 3 years, reduced by the income generated in the 3rd year.

Results and discussion

The average yields of apple production are 32,715 kg/ha which is far from average yields in the countries with competitive apple production such as Italy, Poland, France and others (50,000 – 60,000 kg/ha).

According to the survey, 73% of the total surveyed apple orchards are established on the basis of intensive growing system, followed by the extensive apple orchard system representing 13% and highly intensive apple growing orchard system representing 10%

The results from the research show that the investment costs for establishment of the extensive growing system for the first three years is 10,002 EUR/ha, for intensive system 15,047 EUR/ha, while for the highly intensive system 19,510 EUR/ha or almost twice higher investment costs compared with extensive apple orchards.

Table 1. Specification of investment costs for establishment of apple orchard (in EUR/ha)

Cost for establishment of apple orchard	Extensive	Intensive	Highly intensive
Investment for orchard construction	6,920	10,500	18,089
Growing costs in 1 year	982	1,443	1,715
Growing costs in 2 year	1,153	1,755	1,978
Growing costs in 3 year	1,427	2,349	2,728
Income in 3 year	-480	-1,000	-5,000
Total	**10,002**	**15,047**	**19,510**

In regards to variable costs, the results illustrate that the higher values are within the highly intensive systems. The average yearly costs are amounted at 5,456 EUR/ha, which is for 13% higher compared with extensive and only 11% compared with the intensive growing systems. The variable costs for intensive systems are amounted at 4,859 EUR/ha per year, while extensive have 4,735 EUR/ha.

Table 2. Yearly production cost indicators in EUR per ha (average for the period 2009 – 2013)[1]

Material and operational costs		**Extensive**			**Intensive**			**Highly intensive**		
	Measurement unit	Units	Unit price	Total	Units	Unit price	Total	Units	Unit price	Total
Fuel	l	250	1.12	280	350	1.12	392	400	1.12	448
Protection	No of spraying	9	69.59	640	14	67.54	959	14	72.49	1029
Fertilization	kg	250	1.28	320	400	1.28	512	500	1.28	640
Irrigation (drip by drip)	Yearly	1	75.00	75	1	62.00	62	1	62.00	62
Boxes	No/yearly	269	1.46	394	304	1.46	445	373	1.46	546
Transport costs	t	28	16.26	450	35	16.26	572	55	16.26	898
Winter pruning	Days	33	24.39	805	20	24.39	488	10	24.39	244
Summer pruning	Days	3	24.39	73	6	24.39	146	4	24.39	98
Harvesting (manipulation)	Days	42	20.42	864	39	20.44	805	41	20.42	838
Other labour	Days	25	13.33	333	17	13.33	227	19	13.33	253
Maintenance and other costs	Yearly	1	500.00	500	1	250.00	250	1	400.00	400
Total				**4,735**			**4,859**			**5,456**

The highest yields and income generation can be noticed within highly intensive systems with average yield of 42,050 kg/ha and average yearly income 9,880 EUR/ha. The income is almost twice higher compared with the extensive and one third from the intensive systems.

Table 3. Yearly yields and income (average for the period 2009 – 2013)[2]

	Extensive			**Intensive**			**Highly intensive**		
Apple	Yields (kg/ha)	Sell price (EUR/kg)	Income (EUR/ha)	Yields (kg/ha)	Sell price (EUR/kg)	Income (EUR/ha)	Yields (kg/ha)	Sell price (EUR/kg)	Income (EUR/ha)
	29,610	0.197	5,846	33,470	0.215	7,211	42,050	0.235	9,880

The average yearly profit amounts to 2,975 EUR/ha at the highly intensive growing system, which is almost twice higher compared with the intensive systems (1,575 EUR/ha) and more than four times compared with extensive system (700 EUR/ha).

Table 4. Profit calculation (EUR/ha)

Profit calculation	**Extensive**	**Intensive**	**Highly intensive**
Income	5,846	7,211	9,880
Variable costs (-)	4,735	4,859	5,490
Depreciation (-)	333	602	1,084
Income before taxes	777	1,750	3,306
Tax (10%) (-)	78	175	331
Profit (EUR/ha)	**700**	**1,575**	**2,975**

The production price of one kilogram apples is lowest in highly intensive system amounted to 0.131 EUR/kg, while in intensive the production price is 0.145 EUR/kg and at the extensive 0.160 EUR/kg. The situation is similar with full production price[3] and lowest values are generated within highly intensive systems (0.156 EUR/kg), followed by intensive

[1] The presented values for the total costs and units are calculated as average of the costs and units in the 5 years period. The average unit price is calculated by dividing total costs with units.

[2] The average sell price is calculated by dividing average 5 years income with average yields.

[3] Production price is variable costs divided by the yield. The full production price additionally includes fixed costs.

(0.163 EUR/kg) and highest production price at the extensive production systems (0.171 EUR/kg).

Table 5. Apple production prices (EUR/ha)

	Extensive	Intensive	Highly intensive
Production price	0.160	0.145	0.131
Full production price	0.171	0.163	0.156

The highly intensive systems have shortest payback period and investment will repay in 5 years. The payback period on investment in intensive systems is 7 years, while for the extensive systems this period is longest (11 years).

Table 6. Payback period of investments in apple orchards

Year in project lifetime[1]	Extensive		Intensive		Highly intensive	
	Net inflow	Cumulative net inflow	Net inflow	Cumulative net inflow	Net inflow	Cumulative net inflow
I0	-6,920	-6,920	-10,500	-10,500	-18,089	-18,089
I1	-982	-7,675	-1,443	-11,943	-1,715	-19,804
I2	-1,153	-8,828	-1,755	-13,698	-1,978	-21,782
I3	-1,907	-10,735	-1,349	-15,047	2,272	-19,510
P1	1,033	-9,702	2,177	-12,870	4,059	-15,451
P2	1,033	-8,670	2,177	-10,693	4,059	-11,392
P3	1,033	-7,637	2,177	-8,516	4,059	-7,333
P4	1,033	-6,604	2,177	-6,339	4,059	-3,274
P5	1,033	-5,571	2,177	-4,162	4,059	785
P6	1,033	-4,538	2,177	-1,985		
P7	1,033	-3,505	2,177	192		
P8	1,033	-2,472				
P9	1,033	-1,439				
P10	1,033	-406				
P11	1,033	627				

Net present value at all growing systems is positive, which means that the investment is economically feasible in all cases. Still, the highly intensive production systems demonstrate highest net present value, while the extensive production system has significantly lower net present value compared with other systems. Furthermore, the calculations for internal rate of return illustrate higher values at the highly intensive apple growing system, compared with the other two growing systems.

Table 7. Comparative indicators of economically viability of different production systems

Indicators	Extensive	Intensive	Highly intensive
Internal rate of return (%)	7.10%	9.76%	12.13%
Payback period (years)	13	10	8
Net present value (EUR)	1,204	6,201	10,458
Relative Net present value (%)	12.04%	37.39%	48.02%

Conclusion

The apple production is one of the main perspective fruit in the Macedonian agriculture regarding to climate and soil conditions. Apple takes dominant place according area, production and export. The low productivity and high cost of apple production emerge as major constraints to competitiveness on domestic and world markets, mainly as result of inadequate and obsolete production systems, cultivation practices and technologies.

[1] I – refers to investment period and P – refers to period of production/usage of the apple orchards.

The results from the research demonstrate that the investment value, yield and income vary in line with the apple production systems (trees densities). The highly intensive growing system demand higher investment costs, but gives more positive results. The higher net present value and internal rate of return and earlier payback indicate that investment in this system is economically more appropriate and suitable. Additionally, the high intensive systems result with higher profit and lower production prices. According to these findings, highly intensive growing system is a prerequisite for increasing the competitiveness of the sector. Therefore, the apple growers in Macedonia need to shift to more intensive production systems and introduce new technologies in line with the increased intensity and trees density. Still, the density and growing systems should be adopted towards the variety specifics.

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