International Journal of Plant & Soil Science

31(6): 1-8, 2019; Article no.IJPSS.54277
ISSN: 2320-7035

Agroeconomic Aspects of Project Implementation of Intensive Fruit Farming

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Authors' contributions

This work was carried out in collaboration among all authors. Author BS designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors ER and ES managed the analyses of the study. Authors EM and AM managed the literature searches. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/IJPSS/2019/v31i630229
Editor(s):
(1) Prof. Alejandro Hurtado Salazar, Departamento de Producción Agropecuaria, Fruit Improvement, Physiology of Production, Physiology of Plant Stress, Breeding of fruits, Universidad de Caldas, Colombia.
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Reviewers:
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(2) Maria Raquel Rybak, National Institute of Agricultural Technology (INTA), Argentina.
Complete Peer review History: http://www.sdiarticle4.com/review-history/54277

Original Research Article

Received 01 December 2019
Accepted 04 February 2020
Published 11 February 2020

ABSTRACT

Aim: The aim of this paper is to determine agroeconomic effects of intensifying the cultivation of fruits and the introduction of new technologies in fruit production.
Methods: The project involved 150 farmers. The implementation of the projects took three years. Throughout the project, continuous theoretical training was provided in the form of lectures and presentations, as well as practical training of individuals and groups of 15-20 farmers.
Results: Gradacac area (Bosnia and Herzegovina) has favorable conditions for intensive cultivation of canopy fruit. In addition to the favorable agro-environmental conditions and many unemployed people as well as the tradition of fruit cultivation, they encouraged the Lutheran World Federation -LWF to implement project of intensive fruit farming. The economy of canopy fruit production is conditioned by many factors: the choice of variety, rootstock, training system and location, moreover the intensity of application of agro and pomotechnical treatments, production costs and market price. Intensive fruit production has its specific features and large investments, but as a result it can be said that it is economically viable. The project organized for the first time in

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this area continuous education and long-term monitoring, introduced new grounds, a new training system and maintaining orchards.
Conclusion: It is very important to note that for the Municipality of Gradacac the inflow of funds of over BAM 2 million is enabled every year during the period of full fruiting.

Keywords: Intensive fruit farming; canopy fruit; economy of canopy fruit production.

1. INTRODUCTION

Gradačac Municipality is located in the northeastern part of Bosnia and Herzegovina. Southeast Europe, near the European Union (Croatia) border 40 km away (44.879015°N 18.425791°E). Area: 218 km^2. Population: 41,836. Elevation: 129 m. Climate: Moderately continental. Average temperature: summer 20, 8°C, winter 1.7°C. It has 15,845 ha of arable land, of which 80% is arable land and 20% is orchard. BiH's leading municipality in the production of fruits, of 15,845 hectares of arable land, 80% is arable land and 20% is orchard. Agricultural land suitable for arable farming, fruit growing, horticulture, animal husbandry. Plum, apple, pear and cherry growing is dominant. The Municipality of Gradačac has a long tradition of fruit growing.

The importance of fruit growing is multifaceted, in addition to its importance in the nutrition of the population. Fruit growing is one of the most cumulative agricultural branches, several times higher in value per ha than wheat and maize production. Fruit farming employs more workers per unit area, which directly affects employment.

From the point of view of application of scientific and technical achievements and human participation, the technology of fruit cultivation can be divided into: extensive, semi-intensive and intensive production.

Extensive cultivation technology - characteristics of this technology, the initial level of conventional production, are: the cultivation of single and very lush fruit trees grafted on seedlings, naturally formed canopy, alternative fruiting, late procreation, and usually no level of implementation of agro and pomotechnical treatments. Semi-intensive cultivation technology - this level of conventional fruit production is distinguished by the application of some agro and pomotechnical treatments (usually only winter pruning and fertilization).

Intensive cultivation technology - this level of conventional production is characterized by dense planting, poorly-rooted soil, applying all agrotehnical and pomotehnical measures (adequate tillage, fertilization, irrigation, protection, green and winter pruning). Certainly, only this form of sustainable commodity production is economically viable.

Fruit production in the regions of northern and northeastern Bosnia according to the intensity level belongs to extensive to semi-intensive production. The level of application of science and technology in orchards does not make this production competitive in the market.

In addition, by aggression against BiH in the period 1992-1995. Many orchards were destroyed or omitted due to inability to access and cultivate them. The post-war period involved the restoration of agriculture and, as part of that, the restoration of orchards. Many non-governmental humanitarian agencies supported the restoration and planting of new orchards.

Fruit growing in this region is extensive and because of the need for competitiveness in the market it was necessary to intensify fruit production. The intensification of fruit production meant moving to denser planting from 250-300 plum trees / ha to 700-1000 plum trees per acre or 600-700 apple and pear trees per acre to 2000-3000 apple and pear trees per acre.

In order to make the final decision on the choice of plum planting for the needs of new investment, research was conducted on the optimal number of seedlings per hectare of land.

Based on the results of the analysis, it is recommended that the planting variant of 1000 seedlings per hectare in the observed investment projects is the best alternative for planting a new orchard [1].

Calculation of variable cost coverage for different types of agricultural production can provide a good basis for economic analysis and planning of farm operations [2].

In order to reach the level of competitiveness, several changes in the approach and technology

of fruit production had to be introduced. These changes were reflected in the following:

a) Introduction of low-density substrates
b) Change of the breeding system (introduction of a slender spindle as a breeding form)
c) Change in the maintenance of the row and row space in the orchard (switching to the combined maintenance method – row space with grass and row maintenance without weeds)

Selection of farmers is based on a survey of farmers needs for fruit species. The survey also included questions regarding the area of the adequate land and the willingness of users to attend all types of education, as well as the readiness for consistent application of agro and pomological measures proposed by agronomy engineer hired by the Lutheran World Federation-Switzerland for a period of three years. All respondents were visited by LWF experts, and the accuracy of the allegations and the selection of users were determined. The selection of beneficiaries was followed by theoretical and practical training in planting orchards. The project envisaged a joint venture in such a way that each beneficiary received a package of seedlings and raw materials and his participation consisted of land cultivation, planting of seedlings, placement of seedlings and further care of the plantings.

The reduction of agricultural land and the evident increase in population is a serious task for fruit producers to produce larger quantities of fruit on smaller areas, with the obligation of sustainable land management. One solution is to intensify fruit production and bring it to the level of integral production.

Research has concluded that the yield height in years of entry into full fertility is more influenced by planting density than the influence of rootstock selection and growing system [3].

It is argued that reducing row spacing has more impact on fertility than reducing space between rows [4].

Achieving full fertility is of great importance because it enables the return on investment. In this regard, it is stated that intensive cultivation should be adapted to the "requirements" of the variety. Thus, the cultivation of Idared and the implementation of all agro and pomotechnical measures achieved full fertility in the fifth year [5].

The use of dwarf rootstocks has increased the density up to 3000 - 5000. Although average orchards remain at a planting density of 2500-3000 trees / ha [6].

Use of selected clonal rootstocks can provide many other beneficial characteristics to the orchard tree, such as control of vigor and cropping and tolerance/ resistance to a range of damaging pests, diseases and abiotic stress factors [7].

Rootstocks Lancep and Cepiland tend to increase yields on RDs than on DGs relative to yields on M9 [8].

The semi-dwarfing rootstock Pillnitzer 'Supporter 4'®, a clonal selection of ‘Pi 80', are more frost resistant against winter frost than quince rootstocks, and the growing capacity is intermediate between quince and seedling [9].

Tests in Poland showed that among the rootstocks tested the most suitable for Polish conditions on light soils are P 14, M.26 and P 60. For fertile soils recommended dwarf rootstocks are M. 9 EMLA and M 9 sub-clones, P 59 and P 22 [10].

Research has shown that there were no significant differences in the most important phenological stages (bud break, time of flowering and leaf fall) among rootstocks [11].

Research early performance showed that, during the first four cropping years, the yields/ha were positively correlated with tree density [12].

The effect of rootstock on feathering was a function of their effect on tree vigour; maidens on seedlings, 'Pyrodwarf' and OH×F 333 developed more numerous and longer feathers than on quince [13].

2. MATERIALS AND METHODS

The project involved 150 farmers. The implementation of the projects took three years. Throughout the project, continuous theoretical training was provided in the form of lectures and presentations, as well as practical training of individuals and groups of 15-20 farmers. Farmers are divided into groups due to their spatial layout, less waste of time to education visits, and more efficient work with fewer farmers. All farmers were donated the same packages of planting material and raw materials because of the

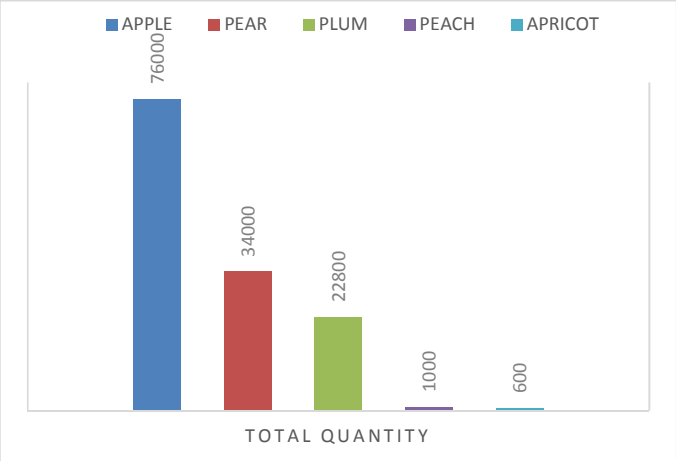
uniformity of the project. As a joint venture, the farmers offered: tillage, planting, purchasing and installing backrests, planting care. Planned and calculated calculations of the production of individual types of fruit were used.

Through the LWF project in the Municipality of Gradacac, 133 620 fruit seedlings were planted:

The package of raw materials consisted of the following in Table 2.

Table 1. Specification of species and varieties of fruits planted in Gradacac Municipality

Species	Varieties	Rootstock	Quantity	Per user	Number of users	Total quantity	Area in ha
	Idared	M9	600				
Apple	Jonagold	M9	200				
	Golden delicus	M9	100				
	Greny smith	M9	100	**1000**	**76**	**76 000**	**45,6**
	Santa Maria	MA	400				
Pear	Butira	MA	200				
	Bella di Juno	MA	200				
	Viliam	Sijanac	200	**1000**	**34**	**34 000**	**23,8**
	Stanley	Džanarika	400				
Plum	Bilska rana	Džanarika	60				
	Č. lepotica	Džanarika	60				
	Č. najbolja	Džanarika	60	**600**	**38**	**22 800**	**38**
	Red heaven	Vinog.breskva	700				
Peach	Indenpendens	Vinog.breskva	200				
	Sun crest	Vinog.breskva	100	**1000**	**1**	**1 000**	**1**
Apricot	Mađarska najbolja	Džanarika sa posrednikom	400				
	Kečkemenska ruža	Džanarika sa posrednikom	100				
	Roxana	Džanarika sa posrednikom	80	**580**	**1**	**600**	**1**
					150	**133 620**	**109,4**



Graph 1. Quantity of species

Table 2. Specification of raw materials

No.	Type of material quantity units of measurement	Quantity	Unit
1	Mineral fertilizer	500	kg
2	Sprayer	1	pc
3	Fruit scissors	1	Pc
4	Protective, plant protection products	1	Pack
5	Rabbit Protection	1	Pack
6	Galvanized wire	1	Pack

3. RESULTS AND DISCUSSION

One of the goals of the project was to increase the density of the plant assemblage due to the faster reaching full fertility and economic justification of fruit planting.

In the northern and northeastern Bosnia regions where Gradačac belongs, orchards with a rare planting pattern were grown. So plums were grown with a distance of 6x5, apples 4x3, etc. The living space of the fruit ranged from 4.56 m2 in the apple to 36 m^2 (apricot).

The number of seedlings and the density of the assembly are shown in Table 3.

From the Table 3 data it can be concluded that the increase in the number of seedlings per ha was significant and ranged from 2 to 2.8 times while reducing or optimizing the living space of the fruit. This increase in the number of seedlings has ensured more economical production and higher revenue.

In Table 4 shows the economic effects of increasing the number of seedlings.

From Table 4 follows the conclusion that an extra profit of 7340 BAM can be obtained annually from a 1 ha area with a dense assembly. It should be noted that the investment costs are higher for a rare plot due to the acquisition and planting of more seedlings. In Table 5 shows the total revenue per year in the orchard exploitation period.

According to research, the determination of the indicators of the economic effectiveness of investments is based on the determination of differences and the relationship between the amount of investment investments made and the realized cash receipts during the investment period [14].

Intensive apple and pear plantings are relatively expensive investments, yet they are economically viable, as evidenced by the indicators of economic efficiency [15].

Table 3. Number of seedlings and density of assembly

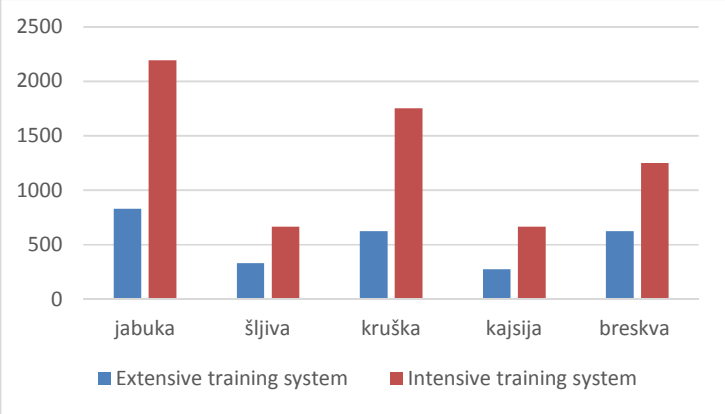
Species	Extensive planting			Intensive planting			Increased number of plants / ha
	Planting pattern m	Living space m^2	Number of plants /ha	Planting pattern m	Living space m^2	Number of plants /ha	
Apple	4 x 3	12	833	3,8 x 1,2	4,56	2192	1359
Plum	6 x 5	30	333	5 x 3	15	666	333
Pear	4 x 4	16	625	3,8 x1,5	5,7	1754	1129
Peach	6 x 6	36	277	5 x 3	15	666	389
Apricot	4 x 4	16	625	4 x 2	8	1250	625

Table 4. Advantages of a dense fruit growing scheme per 1 ha, average cost of 1 kg of fruit 0.50 BAM

Parametres	Planting pattern 4 x 3 m	Planting pattern 3,8 x 1,2 m
Number of plants	833	2190
Yield per plant	35 kg	20 kg
Yield per ha	29 120 kg	43 800 kg
Profit per ha	14 560 BAM	21 900 BAM
The difference in income		7 340 BAM

Table 5. Average yield and revenue per year until full fruition

Species	Number of plants	Yield 2.year	Yield 3.year	Yield 4.year	Full fruition 5.year	Price BAM	Total 2.year	Total 3.year	Total 4.year	Full fruition 5.year
Apple	76000	4	10	18	25	0.50	152000	380000	684000	950000
Pear	34000	5	12	23	30	0.80	136000	326400	625600	816000
Plum	22600	8	18	27	50	0.40	72320	162720	244080	425000
Apricot	600	7	15	30	50	0.60	2520	5400	10800	18000
Peach	1000	8	20	25	25	1.0	8000	20000	25000	25000



Graph 2. Increase in the number of seedlings

4. CONCLUSIONS

The selection and introduction of suitable varieties and rootstocks has enabled the reduction of living space, the number of plants per unit area has been increased.

By reducing the regular spacing between the fruit trees, a faster entry of the fruit into full fertility was achieved.

By adopting a new way of maintaining row space, better and more timely chemical protection of fruit trees is possible.

Timely protection of fruit trees has reduced the cost of protection, improved fruit quality and preserved natural predators.

The hours spent on pruning and harvesting have decreased significantly with the introduction of new farming systems.

The project has increased the employment of the population as orchards have become a source of livelihood for families.

The standard of population has improved as the year-on-year revenue from fruit sales in excess of BAM 2 million has been made possible.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Peer-review history:
The peer review history for this paper can be accessed here:
http://www.sdiarticle4.com/review-history/54277