Economics of Integrated Walnut Production in North-East Slovenia

Jernej Turk, Črtomir Rozman

Faculty of Agriculture, University of Maribor, Vrbanska 30, 2000 Maribor, Slovenia (jernej.turk@uni-mb.si)

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SUMMARY

Fruit production is considered a viable farm business option especially in those areas where the abandonment of agricultural production has become a major agricultural policy issue and concern. Due to high self-sufficiency levels in apple production and owing to low self-sufficiency levels in other fruit sorts in the Slovene food market, an immanent increase in the diversification level of fruit production would be a good opportunity for small-scale fruit growers. Walnut is just one of many fruits which could be grown in marginal areas. However, the farmers would require reliable information on the economic viability of walnut production before any orchard establishment (investment) has actually taken place. A static simulation model was developed in this study to enable comparative cost analysis of integrated walnut production. Because the integrated fruit production is currently a prevailing trend in the Slovene fruit growing, its corresponding production technology was utilised in building up the model. The estimated total costs represent a basis for the calculation of break-even price and break-even yield. The impact of different yields on the break-even price is evaluated by employing the sensitivity analysis. Using the information on the production costs calculation model, the average yearly cash flows are estimated. By applying a cost-benefit analysis methodology, the net present values and internal rates of return are ultimately computed to evaluate the financial aspects resulting from a specific investment project in walnut production.

Key words: walnut production, farm management, simulation modelling

INTRODUCTION

The Slovene agriculture has been encountering a bulk of various problems in the transitional period. One of them is the abandonment of agriculture in marginal areas (e.g., hilly regions). Nevertheless, because of their specific micro-climatic conditions some of these marginal areas are suitable for fruit production. The Slovene fruit production represents around 3,5% of the total agricultural product. One of its main challenging issues is obviously lack of diversification. Apples represent over 80% of the total fruit production and apple growers are already facing considerable market surpluses. An increase in the diversification level would most likely reduce the existing market surpluses. The exceptionally small size of private fruit farms is another major shortcoming of the Slovene fruit production. It should also be stressed here that there has been a significant shift between different types of farms in favour of supplementary (part-time) farms lately. The part-time farming, therefore, remains an important part of agriculture - particularly in the marginal areas. The main question that requires answering is how to ensure economic viability of these small part-time or (in some cases) full-time farms to achieve higher income levels.

Fruit growing could be one of the most adequate responses to further abandoning of agricultural production in the marginal areas. The walnut (Juglans regia L.) is one of numerous fruit kinds that could be grown in these areas. Northeast Slovenia has mixed Alpine and continental climate favourable for walnuts growing. The danger of late summer frosts can be avoided by planting the varieties with very late vegetation start. Since orchard maintenance costs are low, they are productive over 40 years, and production is not labour-intensive, the walnut production appeals to many farmers, part-time farmers and investors. On the other hand, introduction of intensive walnut growing is hampered by very late full yields (in year '7'or even later). Compared with other fruit kinds, walnut is not very labour-intensive; furthermore, all parts of the tree can be used: nuts in nutrition, leafs and roots in pharmaceutical industry and wood in furniture industry. Walnut growing is thus interesting for:

- nut production (intensive orchards)
- combined walnut orchards for nut and timber wood production
- orchards for timber wood production (agro-forestry).

The Slovene walnut industry is small. According to the Statistical Yearbook of Slovenia (1998), there were 100493 walnut trees in 1997. Most of walnut trees are individual trees in backyards, gardens and extensive orchards. The average yield in 1997 was 9,2 kg per tree, which could be attributed to poor cultivation of walnut trees. Slovenia boasts of good climate and soil conditions for walnut growing and this is why Slovene walnut industry has plenty opportunities for its further expansion. According to SOLAR (2000), there are 80 hectares of newly established walnut orchards. Size of those orchards varies between 0,3 and 5 ha, with over 9000 walnut trees planted. Over 25000 walnut trees have been planted in backyards, gardens, and extensive orchards and in tree avenues. The yields in newly established orchards are between 2000 – 3000 kg per hectare. The Slovene walnut producers (and producers of other nut fruits) have their own association within the Slovene Society of Nut Producers.

Establishing and managing a walnut orchard requires making of numerous economic decisions over the long productive life of walnut trees. The crucial decision appears to be whether to grow walnuts in the first place. The next set of decisions refers to the orchard design, its location, walnut varieties, spacing, irrigation and soil management. It is also very important to consider economic issues before making any management decision. This is why a feasibility study must be conducted before the walnut orchard establishment. The feasibility study should answer the following questions:

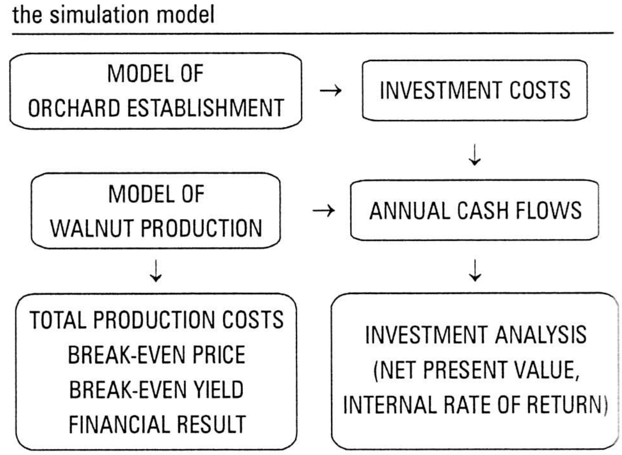
- What are the expected revenues?
- What resources are needed and what resources are available?
- What are the associated costs?
- How much profit can be made? (RAMOS et al., 1998)

The objective of this study is to determine the costs of a walnut orchard establishment, costs of walnut production and to calculate revenues and indicators of investment effectiveness. Due to the fact that the integrated fruit production is currently a prevailing trend in Slovene fruit growing, its corresponding production technology was used in building up the model.

METHODOLOGY

Different methods of costs determination are used in farm management. All the methods include calculations of input quantities applied in the production process. A widely accepted method in farm management is simulation modelling. The Agricultural Institute of Slovenia is already using this method for cost model simulations for different agricultural products. The costs are estimated by using the deterministic static simulation model. The main caveat of the calculations

Figure 1: Calculation of costs and economic indicators with the simulation model



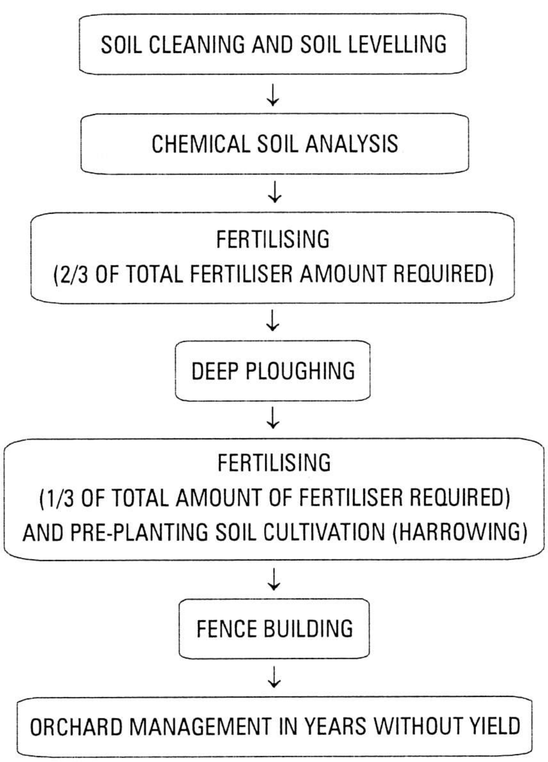
carried out by the Agricultural Institute of Slovenia is a relatively small number of fruit kinds included in their analyses (apples, peaches, pears and strawberries).

The static simulation modelling approach for integrated walnut production is applied here. The process of simulation consists of the following stages:
- Problem formulation and defining the goals of empirical analysis
- System analysis of the problem under scrutiny
- Formulation of the mathematical model
- Calculation of the model using computer spreadsheet programmes
- Model experimentation
- Result analysis and model verification

Problem Formulation and System Analysis of Walnut Production

The walnut orchard belongs to a very specific agricultural system that is determined by the land surface, walnut variety and prevailing technology. The objective of this study is to determine the costs of integrated walnut production, to calculate economic indicators (break-even price, break-even yield and net return per hectare) and, ultimately, to conduct the cost-benefit analysis (CBA).

Figure 2: System analysis of walnut orchard establishment



Constructing the Mathematical Model

The model is divided into two sub-models:
- The model of orchard establishment
- The model of walnut production

The model of orchard establishment calculates the amounts of variable inputs used in the process of orchard establishment. The model of walnut production determines the amounts of inputs used in the production process. By multiplying the calculated amount of inputs with their prices, the production costs are subsequently estimated (production cost calculation – walnut production enterprise budget). The annual cash flows are estimated using the information from this particular calculation. The investment costs and annual cash flows represent the basis for the cost-benefit analysis.

Human and machine labour used in the process of walnut production equal to the time used for individual working operations. There was little research in the area of time usage in the walnut production process. This is why the technological standards (capacities) were used for time usage estimation in operations for which no other data could be found. All the corresponding equations are given in the appendix.

Model of orchard establishment

On the basis of the model developed, the amounts of inputs used in the process of walnut orchard establishment are computed. The calculations are performed using mathematical equations, technological estimations, reference data and the actual data coming from the walnut orchard establishment.

The process of orchard establishment consists of the following working procedures:
- soil preparation, chemical soil analysis and fertilisation
- fence building
- planting
- orchard management in juvenile years (years with no yield)

Table 1 Required material and labour standards for fence building around the orchard

Material and Labour Inputs	Amounts Required	Unit
Pillars	115	m per hectare
Fence wire	461	m per hectare
Barbed wire	461	m per hectare
Support wire	97	Kg per hectare
Hole boring	4.6	Hours per hectare
Tractor labour	9.2	Hours per hectare
Human labour	112	Hours per hectare

Source: Jerič et. al., 1998

a) Soil preparation

Cleaning, levelling and deep ploughing is usually performed by the bulldozer. The amount of hours required for this operation depends of the size of the parcel, the slope and time required for cleaning and levelling. This is why it is very difficult to determine the average amount of required bulldozer hours. According to JERIC et. al. (1998), the average number of hours required for soil levelling and deep ploughing is 44 hours per hectare. Total amount of bulldozer hours required can hence be obtained from equation 1 (see the appendix).

The standard agricultural tractor performs fertiliser distribution. Hours required for the fertiliser distribution depend on the size of the surface and the amount of the fertiliser (see equation 2 in the appendix).

The pre-planting cultivation (harrowing) is taking place after the processes of fertilising and deep ploughing have been completed. The time required for harrowing is defined in equation 3.

b) Fence building

A fence must be built to protect the orchard against all possible damage that can be inflicted on young trees by rabbits, deer and other animals. The fence construction clearly represents an additional cost in the process of orchard establishment.

Total quantity of inputs required for fence building amounts to values from Table 1 multiplied by the total orchard surface (P).

c) Planting

The number of trees depends on distances between rows and distances between trees in rows. Time necessary for planting depends on the number of trees and planting standard (equations 4 and 5).

Other inputs required for planting:
- Stocks (number of stocks equals number of trees)
- Tractor labour transport (estimated – 27,7 hours)
- Organic fertiliser - manure (MANURE = P * 18000 kg)

d) Orchard management in juvenile years (years with no yield)

One of the main traits of all walnut species is very late beginning of the first yields. In the model, the first estimated yield is expected in year '8'. Costs of orchard management in the first seven years are therefore included in investment costs (costs of orchard establishment). The mathematical equations used to calculate times and amounts of inputs are the same as in the walnut production model. The value of the yield in the first years is deducted from the costs of orchard establishment.

Model of walnut production

The extent of walnut production costs largely depends upon the amount of inputs used. These amounts are estimated by technological model and are presented in the technological chart. The working operations, which are required in the process of integrated walnut production, are shown in Figure 3.

a) Fertilising

A standard agricultural tractor with appropriate implements (machines for fertiliser distribution) performs potassium and phosphorus fertilisation. The following inputs are required:
- machinery labour (tractor and fertiliser distributor)
- fertiliser

The machinery standard requirement can be derived from equation 6.

In orchards with integrated production the amount of the fertiliser is estimated on the basis of chemical soil analysis. Since that amount varies and depends on the actual potassium and phosphorus amounts in the soil on different parcels, fertiliser quantities used in the model are estimated by considering the annual nutrient seizure from the soil (yield). However, the levels of nutrient elements should not exceed C levels in the integrated fruit production.

b) Soil management

Northeast Slovenia is characteristic for sufficient moisture (rainfall), which enables a combined process of grass mowing and herbicide application in the walnut orchard. The grass must be mown at least once a month (six mowings per season). However, the area around trees should be cultivated or kept clean by herbicide application or cultivation. According to the standards of TOJNKO (Slovene Integrated Fruit Production Association, 1998), one third of the total orchard area can be treated with herbicides, while the remaining two thirds of the total orchard surface is mown with the standard agricultural tractor. Machinery (tractor) and human labour intakes are required for this operation. The number of tractor hours can be determined using the equation 7.

One third of the soil (area around the trees) is treated with herbicides in spring and in late summer. The following inputs are required:
- herbicide (two sprayings per season)
- machinery intake

The amount of herbicide and amount of required tractor hours can be computed from equations 8 and 9.

c) Nitrogen fertilising

In the beginning of the growing season only a part of the total amount of the nitrogen fertiliser is distributed. This calls for the additional nitrogen fertilising application during growing season. The following inputs are required:
- nitrogen fertiliser (KAN[1])
- tractor (machinery) intake

The machinery requirement can be calculated using the equation 10.

d) Pest management

Most of the walnut trees planted in extensive orchards and backyards are not sprayed. However, there are some pests and diseases that can cause significant economic damage (yield reduction) to an intensive walnut orchard. We are referring mainly to walnut blight (Xanthomonas campestris pv. juglandis), walnut antrachnose (Gnomonia leptostyla), apple and walnut codling moth (Carpocapsa pomonella and Carpocapsa amplana) and aphids (Chromapsis juglandicola and Callaphis juglandis). Decision to spray a particular pesticide. Is based on pest monitoring results. Number of sprayings varies in different seasons. In this model, the number of sprayings is determined in a spraying plan (calendar) elaborated on the basis of experience from previous year(s). The amount of pesticides used is estimated using the information from the spraying plan and the hectare pesticide dosage. The number of tractor hours required for sprayings is determined by equation 11.

e) Pruning

The process of pruning is necessary to enable regular and quality yields. In Slovenia, the pruning of walnuts is conducted only manually (saw and scissors). The amount of labour hours required is obtained from equation 12.

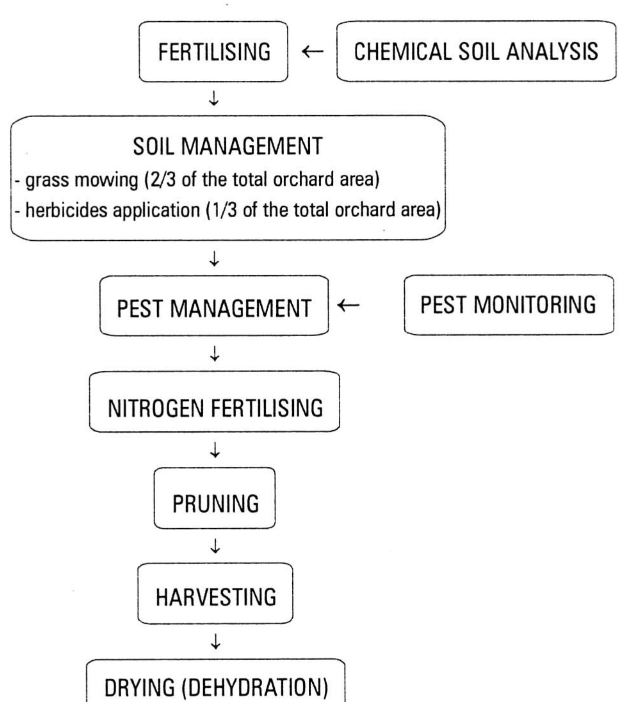
f) Harvesting

Time required for harvesting can be estimated from the equation 13.

g) Drying

According to JERIC et al. (1998), 24 hours of human labour are required for drying.

Figure 3: Integrated walnut production process



[1] KAN = Calcium ammonium nitrate

Table 2 Costs of walnut orchard establishment

ORCHARD SURFACE (SIZE) =	1,0	ha	
DISTANCES BETWEEN ROWS =	10,0	meters	
DISTANCES IN ROWS =	8,0	meters	
STATE SUBSIDIES FOR ORCHARD RENEWAL	278.400	SIT	
Costs	kg, l, SIT	SIT/kg, l, hour	SIT
1.Soil preparation			
Soil analysis (4 samples)	4,0	3.500	14.000
Bulldozer	44,0	5.200	228.800
NPK 0:20:30 fertiliser	2.000,0	33,6	67.200
Machinery intake	18,2	1.986	36.145,2
Human labour	51,0	700	35.700
2. Fence			
Pillars	115,0	800	92.000
Fence wire »farmer«	461,0	328	151.208
Barbed wire	922,0	27,38	25.244,36
Support wire	97,0	178	17.266
Hole boring	4,6	2.067	9.508,2
Machinery labour	9,2	1.986	18.271,2
Human labour	112,0	700	78.400
3. Planting and orchard care in year '1'			
Plants	125	3.500	546.875
Manure	18.000,0	5	90.000
Support stocks	125	80	10.000
Binding material	1,0	720	720
Grass seeds	36,0	790	28440
Grass sowing	1,2	1.986	24.09,68
Cuprablau	1,0	674	674
Captan	1,0	1.149	1.149
Copper dithane	1,0	1.277	1.277
Herbicide (boom effect)	1,7	1.955	3.258,3
Machinery intake	27,7	1.986	54.919,5
4. Orchard management in year '2'			97.386,3
5. Orchard management in year '3'			104.686,27
6. Orchard management in year '4'			123.993,87
7. Orchard management in year '5'			108.286,2
8. Orchard management in year '6'			149.893,9
9. Orchard management in year '7'			198.893,9
Total costs =			2.187.231
- value of yield in years 1-7	156.500,0		-156.500
Costs of orchard establishment			2.030.731
-state intervention for orchard renewal	278.400,0		-278.400
INVESTMENT COSTS (I)			1.752.331
		EUR =	8.414

Source: Rozman et. al. (2000)

Table 3 Walnut production enterprise budget

Orchard surface:	1		
Yield:	3.000	kg	
Number of trees:	125		
Investment costs:	1.752.331	SIT	
Output price (nuts in shell)=	300	SIT/kg	
Total revenue=	900.000	SIT	
Depreciation period	40	years	
Material	kg, l, hours	SIT/kg, l, hours	SIT
Cuprablau 1x	5	674	3.370
Copper dithane 2x	5	1277	6.385
Captan 1x	5	1149	5.745
Basudin	2,5	2592	6.480
Sacks	100	30	3.000
NPK 7:20:30 fertiliser	700	33,6	23.520
KAN 27 % nitrogen fertiliser	222,2	27,8	6.177,78
Boom effect herbicide	3,3	1.955	6.516,67
Machinery intake			
Sprayings	6,6		
Mowing	11,0		
Fertiliser distribution	1,94		
Herbicide application	2,40		
Transport	4		
MACHINERY INTAKE	26,0	1.986	51.589,7
Human labour			
Pruning	20,83	700	14.583,3
Harvesting	379,75	700	265.823
Drying	24	700	16.800
Human labour with tractor	26	700	18.183,7
Fixed costs			
Depreciation			43.808,3
Social care			74.271
Taxes			10.364
Overhead costs			28.409
Capital costs			34.253,9
Total costs			619.280
- direct payment for integrated fruit production			-54.000
Total costs for computation of break-even price			565.280
		=	EUR 2.714
Break even price =	188,4	SIT =	EUR 0,90
Break even yield =	1.884,0	kg / ha	
Or	15,0	kg / tree	
Cash flow analysis:			
Cash inflows =	954.000,0	SIT =	EUR 4.581
Cash outflows =	541.217,9	SIT =	EUR 2.599
Net annual cash flow (CF)=	378.528,1	SIT =	EUR 1.817
Net return per hectare =	334.720,0	SIT =	EUR 1.607

Source: Rozman et. al. (2000)

RESULTS

Calculation of the Model Using Computer Spreadsheet Programmes

The computer spreadsheet programme was used in building up the model. Input quantities used were calculated and multiplied by their prices. Average prices on the Slovene agricultural input market were employed here. The model represents the empirical basis from which several model calculations were derived:

- costs of orchard establishment
- costs of walnut production (walnut production enterprise budget)
- investment analysis (cost-benefit analysis)

Results of the sub-model of orchard establishment are derived from calculation of the costs of walnut orchard establishment. All calculations pertain to one hectare.

The result of the sub-model production is the walnut production enterprise budget.

Fixed costs were calculated for a hypothetical 4 ha supplementary (part-time) fruit farm with only one family member fully employed on the farm. The break-even analysis shows the break-even yield of 1884 kg/ha (the price for nuts in shell = 300 SIT/kg) which can easily be achieved with the current technology prevailing in intensive walnut orchards.

This computer spreadsheet program also enables cost-benefit analysis and calculates net present values by several different discount rates. Equation 1' determines the computation of net present values (NPV):

$$NPV = - I + \Sigma(CF / (1 + r)^t \qquad (1')$$

Where:

NPV - net present values

I - investment costs (cost of walnut orchard establishment)

CF - annual cash flows (assumption: constant annual cash flows)

r - discount rate

t – year

Tables 4 and 5 show net present values calculated at different prices and different yields.

The interpolation method was used for computing the internal rate of return (IRR):

$$IRR = A + ((B-A) * C / (C - D)) \qquad (2')$$

Where:

A – the highest discount rate that still results in positive net present value (A = 21%)

B – the lowest discount rate that already results in negative net present value (B = 22%)

Table 4 Net present values with sensitivity analysis (yield = 3000 kg / ha)

	discount rates								
Output price	8%	10%	12%	14%	16%	18%	20%	22%	24%
200	936.418	-984.400	-1.104.962	-1.194.385	-1.262.826	-1.316.645	-1.359.957	-1.395.510	-1.425.190
250	2.725.110	482.458	131.604	-128.629	-327.801	-484.422	-610.467	-713.931	-800.305
300	4.513.802	1.949.316	1.368.171	937.127	607.224	347.801	139.022	-32.352	-175.419
350	6.302.494	3.416.173	2.604.737	2.002.884	1.542.248	1.180.024	888.512	649.226	449.466
400	8.091.186	4.883.031	3.841.304	3.068.640	2.477.273	2.012.247	1.638.002	1.330.805	1.074.352

Source: Rozman et. al. (2000)

Table 5 Net present values at the price Cy=300 SIT / kg with sensitivity analysis (effect of different yields on the net present value)

	discount rates								
Yield	8%	10%	12%	14%	16%	18%	20%	22%	24%
1500	878.754	-1.031.688	-114.826	-1.228.743	-1.292.969	-1.343.474	-1.384.119	-1.417.483	-1.445.335
2000	2.090.437	-38.020	-307.160	-506.786	-659.571	-779.715	-876.405	-955.772	-1.022.030
2500	3.302.119	955.647	530.505	215.170	-26.173	-215.957	-368.691	-494.062	-598.724
3000	4.513.802	1.949.316	1.368.171	937.127	607.224	347.801	139022.4	-32.352	-175.419
3500	5.725.485	2.942.983	220.583	1.659.084	1.240.621	911.559	646.736	429.357	247.886
4000	6.937.167	3.936.651	3.043.502	2.381.041	1.874.018	1.475.318	1.154.450	8.911.067	671.191

Source: Rozman et. al. (2000)

C – positive net present value at lower discount rate (C = 49304)

D – negative net present value at higher discount rate (D = -32352)

IRR was computed at given yield (Y) = 3000 kg/ hectare and corresponding output price (Cy) = 300 SIT/kg. Internal rate of return was equal to 21,6%.

The cost-benefit analysis (CBA) shows positive net present values (all discount rates) given the output price Cy = 350 SIT/kg. Since the annual inflation rate in Slovenia for the period observed (1999) was around 8%, whereas the interest rates were between 10 and 12%, we can assume that investment in the walnut orchard could be economically viable providing the expected yields and prices be achieved.

Model Experimentation

The sensitivity analysis shows effect of different yields on the economic result obtained.

The price of walnuts in shell varies over season. The price is the highest in the period before harvesting (second half of August and first half of September). However, the yield should not fall bellow 2000 kg per hectare.

Table 7 shows effect of different output prices on the break-even yield and net return per hectare. It is demonstrated that the economic results derived are positive, given the most plausible price (300 SIT/kg).

Model Results Comparability (Model Verification)

The results obtained in our study were compared with other analyses tackling the issue of the economics of walnut production such as gross margin computation of Slovene Agricultural Extension Service and the research study of University of California (Establishing a walnut orchard and produce walnuts). The results of the American study show higher net returns per hectare (Acre), which can be explained by the fact that walnut production in California is more intensive, almost fully mechanised and, last but not least, productivity levels are significantly higher. The results derived in this study are, however, comparable with the results of the gross margin calculations undertaken by the Slovene Agricultural Extension Service.

Table 6 Sensitivity analysis (effects of yield on total costs, break-even price and net return per hectare)

Yield	Total costs (SIT / ha)	Break even price (SIT/kg)	Net return per hectare (Cy = 300 SIT / kg)[1] (SIT)
1000 kg / ha	371.728	371,0	-71.727,67
2000 kg / ha	468.504	234,3	131.496,00
3000 kg / ha	565.280	188,4	334.719,93
4000 kg / ha	716.056	165,5	537.943,72

Source: Rozman et. al. (2000)

[1] Cy - output price

Table 7 The sensitivity analysis (effects of different output prices on break-even yield and net return per hectare)

Output price (nut in shells)	Break even yield kg / ha	Net return per hectare (SIT)
200 SIT /kg	5.653	-265.280
300 SIT /kg	2.826	34.719
400 SIT /kg	1.884	3.334.719
500 SIT /kg	1.413	634.719
600 SIT /kg	1.130	934.719
700 SIT /kg	942	123.719

Source: Rozman et. al. 2000

DISCUSSION

The walnut production could be economically viable provided the expected yields and prices be achieved. The CBA analysis has give positive indicators for expected average yields and output price (Y = 3000 kg/ ha and Cy = 300 SIT/kg).

As mentioned earlier, the main shortcoming of the walnuts is their long juvenile period (late first yields). As shown in Table 2, the highest cost in walnut orchard establishment is the orchard management in juvenile years (35%). This is why the production switch towards walnut production on full-time and part-time farms should be conducted gradually in order to avoid a decline in income. Plants represent another 25% of total establishment costs. Relatively high price of selected (grafted) planting material is a result of expensive reproduction process in walnut nurseries. The fact that there are only three walnut nurseries in Slovenia also contributes to high plant prices and consequently high orchard establishment costs. The fence contributes with around 18% to establishment costs. These costs can be avoided if the fence is replaced with individual tree protection.

In the walnut production, costs of human labour represent 53% of total costs. This share is relatively high in comparison with walnut production in other important walnut producing countries (USA, France, Russia) where production is almost completely mechanised. The small size of Slovene fruit farms is a contributing factor that results in high fixed machinery costs per hectare (unit). Use of mechanisation in walnut industry should, therefore, be conducted in form of "machine communities". This could be a difficult task for Slovene walnut producers since the walnut orchards are scattered all over the country. This is why the share of labour costs is likely to remain high.

The enterprise budgets resulting from the model are just estimates, and can only serve as orientation in preparing the actual enterprise budgets and planing in fruit farm management. However, the developed computer model can easily be tailored to actual circumstances on individual farms (by changing the input parameters).

It is our firm belief that structural changes in favour of walnut production should be connected with structural policy measures due to very high investment costs. This should be complemented with strong educational activity of the Agricultural Extension Service since the technology of walnut production is, to some extent, specific and sophisticated technological procedure (especially for former livestock producers).

CONCLUSIONS

The static simulation model was developed in this study to enable the comparative cost analysis in integrated walnut production. The static simulation cost model consists of two sub-models, one for orchard establishment (investment costs calculation) and another for walnut production (production costs calculation). The analyses showed that walnut production may be economically viable provided the expected yields (around 3000 kg/ha) are achieved and yields sold for the expected price (300 SIT/kg). The deterministic simulation model facilitates calculations for different planting systems (different tree densities) and different technologies. Some other advantages, such as possibility of timber sale after the end of walnut orchard productive life cycle, were not taken into account in constructing the model. The walnut production could, therefore, be a good production strategy for both part-time and full-time (small-scale) farmers. It must also be stressed here that the technology used in building up the model is fully intensive under the Slovene circumstances. The intensity can be a crucial factor in compiling the total costs of production. It is also clear that orchard owners must have a very good management and marketing skills to undertake the functions of planning, implementation and control. In this light, the static simulation model developed here could provide us with an extremely useful tool in making sound farm management decisions in walnut industry.

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MISCELLANEOUS

List of equations used in the model:

$$BD = P * 44 \tag{1}$$

Where:
BD - bulldozer hours required per hectare
P - total orchard surface (hectare)

$$\text{TIME FOR FERTILISING} = 1{,}2 * P * Cap * NPK / V \tag{2}$$

Where:
P – total orchard surface
Cap – capacity of the fertiliser distributor (hours per hectare)
NPK – amount of fertiliser needed (NPK = nitrogen, phosphorus and potassium)
V – capacity of the fertiliser tank (l, kg)

1,2 – correction factor (time needed for turning, transport and machine preparation)

HARROWING = 1,2 * P * Caph (3)

Where:
HARROWING – time needed for harrowing
P – total orchard surface
Caph – capacity of the machine (hours per hectare)
1,2 – correction factor (time needed for turning, transport and machine preparation)

NT = P * 10000 / (mvr * vvr) (4)

Where:
NT - number of trees
P - total orchard surface
mvr - distances between rows
vvr - distances inside rows

PLANTING = NT / PN (5)

Where:
NT - number of trees (plants)
PN - planting standard (planted trees per hour)

TIME FOR FERTILISING =
=1,2 * P * Cap * PNPK / V (6)

Where:
P – total orchard surface
Cap – capacity of the fertiliser distributor (hours per hectare)
PNPK – amount of fertiliser needed (kg)
V – capacity of the fertiliser tank (l, kg)
1,2 – correction factor (time needed for turning, transport and machine preparation)

MOWING = 1,2 * NM * 2/3 *P * Capm (7)

Where:
MOWING - hours required for mowing
NM - number of mowing in one season (NM = six)
P - orchard surface (hectare)
1,2 - correction factor (time needed for machine preparation, transport and turning)
Capm - capacity of the machine (hours per hectare)

HERBICIDE = HD * P * 1/3*2 (8)

Where:
HERBICIDE - amount of herbicide
HD - dosage of herbicide per hectare (kg, L per hectare)
P - orchard surface (hectare)

HAP = 1/3*P*Caph*1,2 (9)

Where:
HAP - time required for herbicide application (hours)
Caph - capacity of the herbicide sprayer

AD. FERTILISING = 1,2 * P * Cap * KAN / V (10)

Where:
AD. FERTILISING - amount of tractors hours required for additional nitrogen fertilising
P – orchard surface (hectare)
Cap – capacity of the fertiliser distributor (hours per hectare)
KAN – amount of fertiliser needed (kg); KAN=220 kg
V – capacity of the fertiliser tank (l, kg); V = 400 L
1,2 – correction factor (time needed for turning, transport and machine preparation)

SPRAYING = NS * caps * P * 1,2 (11)

Where:
SPRAYING - total time needed for sprayings (hours)
caps - capacity of the sprayer (h/ha)
P - orchard surface (ha)
NS - number of sprayings (NS = four)
1,2 - correction factor

PRUNING = NT / PN (12)

Where:
NT – number of trees
PN – pruning standard (trees per hour); PN = six

HARVESTING = Y / PIN (13)

Where:
Y – yield (kg)
PIN – harvesting standard (kg per hour)

Ekonomika integralne proizvodnje oraha u sjeveroistočnoj Sloveniji

SAŽETAK

Proizvodnja voća smatra se ekonomski prihvatljivom poljoprivrednom aktivnošću, posebice u područjima u kojima je napuštanje poljoprivredne proizvodnje postalo veliki problem. Zbog visoke razine samodostatnosti proizvodnje jabuka, te niske samodostatnosti proizvodnje drugih vrsta voća u Sloveniji, za male uzgajivače voća je diverzifikacija u proizvodnji dobra poslovna prilika. Orah je jedna od brojnih voćnih vrsta koje se mogu uzgajati u rubnim područjima. Međutim, poljoprivrednicima su potrebne pouzdane informacije o ekonomskoj opravdanosti proizvodnje oraha prije ulaganja u voćnjak.

U okviru istraživanja za ovaj rad izrađen je statički simulacijski model kako bi se omogućila poredbena analiza troškova integralne proizvodnje oraha. Budući da je integralna proizvodnja voća danas prevladavajući trend u slovenskom voćarstvu, za model je rabljena odgovarajuća tehnologija proizvodnje.

Procjena ukupnih troškova predstavlja osnovicu za izračunavanje i proizvodne točke pokrića u modelu. Utjecaj različitih priroda na cijenovnu točku pokrića procjenjuje se pomoću analize osjetljivosti. Prosječni godišnji novčani tokovi procjenjuju se temeljem modela za izračun proizvodnih troškova. Primjenom analize troškova i koristi, na koncu se izračunava sadašnja neto vrijednost i interna stopa rentabilnosti kako bi se mogli ocijeniti financijski aspekti određenog investicijskog projekta vezanog uz proizvodnju oraha.

Ključne riječi: orah, upravljanje, gospodarstvo, simulacija, model