Agricultura 2002, Vol. 1; 28-33

A feasibility study of fruit brandy production

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Fruit brandy production is considered as one of the very many possibilities for home fruit processing. When considering to set up new farm business, the information regarding the economic feasibility of individual agricultural households should be obtained by each farm entrepreneur. The simulation cost model for Slovene brandy production on the fruit farms is developed in this study. The break-even price and break-even yield were calculated for different kinds of fruit brandy. The sensitivity analysis was simultaneously conducted in order to determine the impact of different prices on the net financial result gained. The results show that home fruit brandy production could be economically feasible. The highest financial result was achieved with plum brandy production, followed by pear brandy production and peach brandy production. Several aspects of tax legislation concerning the brandy production are also discussed here. Agricultura 1: 28-33 (2002)

Key words: fruit production; brandy; costs; simulation model

INTRODUCTION

The so-called alternative (supplementary) production on farms has been encouraged by the Slovene agricultural policy makers in recent years. Implementation of additional farm products should, ideally, increase the farm incomes earned. The prices of home fruit products (such as brandy, dry fruit, vinegar and cider) are much higher than the prices of fruits sold directly to the fruit processing industry. However, the vague and insufficient legislation severely hinders the full implementation of home fruit processing in Slovene relations.

The fruit brandy is one of many possibilities that the fruit growers have for home fruit processing. Until 1999, Slovenia has been one of few countries with no taxes imposed for home produced strong alcoholic beverages. In 1999, however, the tax was enacted and since then every owner of the distillation equipment has been compelled to report annual brandy production to the tax collectors.

Fruit brandy is a traditional Slovenian farm good. The plum brandy (produced mostly in regions of Prekmurje and Štajerska) also called “slivovitz” is known world-wide. In the central region of the country the mixed fruit brandy is produced (“sadjevec”; which originally means the fruit brandy). The William’s pear brandy (“viljamovka”) can be found in the areas with predominant pear production. When brandy is made there is also a variety of options to produce different kinds of liqueur. The walnut (made of fruit brandy, sugar and green walnuts in the husks) and blueberry liqueurs are the most known liqueur products.

The objective of this paper is to determine the cost structure of home brandy production. In this way the reliable information will be provided so that the farmers, who are considering a brandy production, would be given an empirical support for a decision making regarding alternative (brandy) production.

METHODS

The simulation model is developed in order to estimate the incurring costs pertained to brandy production. The amounts of inputs used during processing activities and outputs yielded (amount of brandy produced) were derived on the basis of numerous technological equations. This simulation model is classified as a static technologic-economic model where the process of simulation consists of the 5 (five) following stages:

I. Problem formulation and definition of study objectives
II. System analysis
III. Formulation of the mathematical model
IV. Calculation of the model using computer spreadsheet programmes
V. Experimenting with the model, model results and their verification

Problem formulation and definition of study objectives

The objectives of this study are:

- to develop a decision support tool for fruit farms
- to determine the costs of home brandy production
- to calculate indicators of the economic feasibility of brandy production

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System analysis of brandy roduction

The process of brandy production is depicted in figure 1. A first stage of the process is picking, followed by removing of stones (stone fruit) and mixing (grinding) of apple and pear. The fruit is then picked into barrels where alcoholic fermentation is taking place. When fermentation is finished the processed fruits are distilled (first and second distillation) in order to produce brandy with high alcohol percentage. A home made brandy usually contains around 50 % of alcohol.

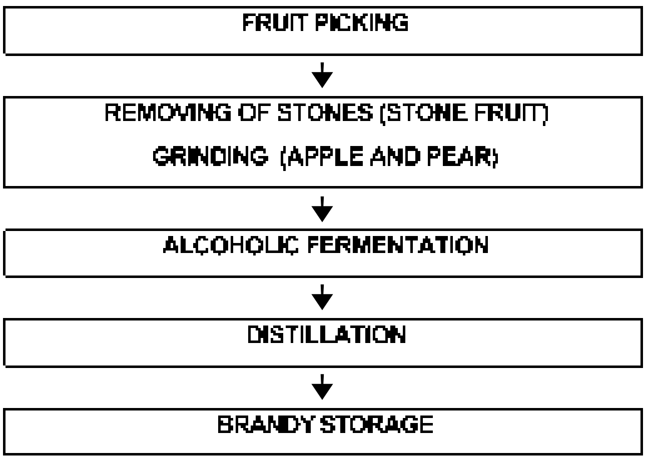

Fig. 1. Process of fruit brandy production.

Formulation of the mathematical model

During this particular stage of the simulation, mathematical equations are developed which represent the genuine picture of relationships existing between various parameters of the model.

1. Fruit picking

The fruit which cannot be sold owing to different reasons (damaged and/or over mature fruits) is usually rather used for home processing. The first operation in brandy production process is picking the fruits. The time necessary for this operation is determined by the amount of the fruit that needs to be picked and its picking capacity (normative).

$$Pic = Y / pn \tag{1}$$

Where:

Pic – time needed for picking
Y – total amount of fruits used for brandy production
pn – picking normative
t is estimated that approximately 2 hours of tractor labour are required in order to transport yield to the place of processing.

The next stage in the process is grinding (apple and pear) or removing of stones and smashing of fruits (peach, apricot and plum), since the stones contain some amount of HCN acid which passes over into brandy during the distillation process (e.g., HCN can be toxic). All these processes are required in order to get a juicy fruit mass and to enable optimal conditions for alcoholic fermentation. Cherry and sour cherry smash themselves because of their own weight and neither of those processes are required for producing brandy out of those two fruit kinds.

Time necessary for grinding (removing of stones) is determined by the following equation:

$$Tm = Y / Cm\ (Rm) \tag{2}$$

Where:
Tm – time needed for grinding (hours)
Cm – capacity of the machine (kg/hour)
Rm – normative necessary for removing stones

A process of removing the stones is performed manually; whereas a process of grinding is conducted using the electrical mixer. The electric power used in the process is determined by the power of the machine and the time of operation (Tm as derived in equation 2).

$$EE = Pe * Tm \tag{3}$$

Where:
EE – electric energy (power) used (kWh)
Pe – power of the machine (kW)

The fruit mass prepared, as described earlier, is afterwards put inside barrels where the alcoholic fermentation is being evolved. Second-hand used plastic barrels are generally used for this purpose.

$$Nb = Y / Cb \tag{4}$$

Where:
Nb – number of barrels
Cb – capacity (volume) of the barrel

2. Distillation

The alcoholic fermentation takes around 2-3 weeks (if temperatures are low even longer). After the process of alcoholic fermentation is completed, a distillation can commence. Distillation equipment consists of copper boiler and cooler which are connected with the copper pipes. The cooler is filled with cold water that cools off the gas alcohol and shifts it back to the fluid. The energy source estimated in the model is a fluid gas which is stored in 10 kg bottles. The 100 l distillers are usually used for home brandy production.

The process of distillation consists of two stages: first; the fermented fruit mass is processed and second; the product (brandy with 20-25 vol % of alcohol - also recognised as a soft brandy) of first distillation is distilled again to ensure the quality and to enhance the alcohol percentage up to 40-50 vol % (Šertelj 1995).

To capture the time effect, a model is divided into individual stages (fillings). One filling consists of one boiler filling, distillation and emptying the boiler. A number of fillings depends on the fruit mass volume and the volume of the boiler. It is, hence, calculated as follows:

$$Nf = Y / Bc \quad (5)$$

Where:

Nf – number of fillings
Bc – boiler capacity (l)
Bc = 0.9 * Vb (usually 90 % of the boiler volume is filled due to safety reasons)
Vb – volume of the boiler (l)

The gas applied is estimated given the fact (based on experience) that with one (10 kg) gas bottle three fillings (270 l of fruit mass) of 100 l boiler can be processed. Therefore:

$$G = Gf * Nf \quad (6)$$

Where:
Gf – gas used per one filling (kg)

$$Gf = 10 * Cb / 270 \quad (7)$$

Because the soft brandy is re-distilled the total number of fillings depends on the amount of soft brandy produced as it can be gleaned from the equation below:

$$TNf = Nf + SB / Cb \quad (7a)$$

Where:
TNf – total number of fillings
SB – amount of soft brandy produced

The result of first distillation is usually soft brandy with 25-30 % of alcohol. The time used for one filling usually takes from 5 to 6 hours. The total time usage (that equals amount of human labour) is, thus, calculated as a product of Tnf and Ft (time of one filling):

$$Td = TNf * Ft \quad (8)$$

Td – total time of distillation

Another input that needs to be considered here is the use of cold water that is present in the cooler. The volume of the cooler is 226 litres. It is envisaged that around 70 l of water must be changed after each filling due to the warming effect (the water in the cooler must namely remain cold in order to enable undisturbed and slow pace distillation). Total water usage, thus, equals:

$$Wt = (226 + TNf * 70) / 1000 \quad (9)$$

Where:
Wt – total water usage (m^3)

Total brandy output at the end depends mainly on the percentage of sugar in fruits. In theory, 100 g of sugar can yield 48.4 g of alcohol (ethanol) that equals 61 ml of pure alcohol. But the experience has shown that these amounts are to some extent lower and that out of 100 g of sugar around 56-59 ml of pure alcohol can be expected (Gavrilović and Janda 1978).

Therefore, around 59 ml of pure alcohol out of 100 g of sugar can be produced. The result of a second distillation is usually a brandy with 55-60 % of alcohol. The amount of highly concentrated brandy (W) equals:

$$W = Sp * 0{,}59 * Y *100/60 \quad (10)$$

Where:
W – amount of highly concentrated brandy (60%)
Sp – sugar percentage in fruit

The input application that follows during this process is distilled water in order to reduce alcohol percentage from 55-60 % (which is common after the second distillation) to 40-50 %. Equation 11 demonstrates the connection between alcohol percentage and usage of distilled water:

$$DW = (k * w) / 100 \quad (11)$$

Where:
DW – amount of distilled water needed
k – contraction number
w - litres of highly concentrated brandy (60 %)

Contraction number is the amount of the distilled water that needs to be added to 100 litres of high alcohol percentage brandy in order to achieve a percentage of alcohol targeted. The contraction numbers can be found in reference literature.

The total brandy output (with 50% of alcohol) is ultimately calculated:

$$Tbo = Y * Sp * 0.59 * 100/50 \quad (12)$$

Where:
Tbo – total brandy output

Calculation of the model using computer spreadsheet programmes

Equations are set within the "Excel" spreadsheet programme. Equations represent the amounts of inputs used that are calculated as described previously and then multiplied with their prices.

Total time used in the process of brandy production equals home (farm) labour. The costs of farm labour represent opportunity costs and are calculated from the net average monthly wage.

Computation of the tax:

The tax is 500 SIT per litre of pure (100 %) alcohol produced above the home consumption level allowed - which corresponds to 14 l of 50% brandy per family member. The tax per litre of 50% brandy is therefore 250 SIT.

$$Tax = (TBo – Hc) * 250\ SIT/l \quad (13)$$

(for brandy with 50% alcohol)

Where:
TBo – brandy produced
Hc – home consumption (l)

$$Hc = Nfm * 14 \quad (14)$$

Where:
Nfm – number of family members

Derivation of fixed costs:

The fixed costs were included in the model as follows:
- depreciation value of the distiller
- depreciation value of the plastic barrels
- depreciation value of the mixer

All depreciation calculations were carried out using linear method which predicts the constant annual depreciation costs:

$$D = PV / n \quad (15)$$

Where:
PV – purchase value
D – depreciation
n= 20 years (for distiller)

For barrels;
n =10 and for mixer n=20 years.

Although the mixer is not used when producing brandy out of stone fruit, depreciation is still retained in all calculations since most farmers produce brandy from a big variety of fruit species, and the purchase of mixer is clearly a necessity.

Because the brandy production is a supplementary production activity only fixed costs that are related (allocated) to the brandy production were included into the costs calculations. Other farm fixed costs were not considered when constructing the enterprise budget.

RESULTS AND DISCUSSION

Experimenting with the model, model results and their verification

A direct result coming out of a simulation model is a brandy production enterprise budget. All cost model simulations were carried out for the family farm of four members and for fruit mass amounting to 1000 kg (Y=1000 kg). The sensitivity analysis shows the impact of different brandy prices on the net financial result gained as a difference between total revenue and total costs.

As it can be gleaned from tables 1, 2 and 3, the highest net financial results were achieved in plum brandy production. This can be explained by the fact that a plum variety ("bistrica"), which is in most cases used for brandy production, contains the highest sugar percentage – resulting, hence, in higher brandy outputs. By calculating the breakeven yield lower price of brandy (p_y = 1000 SIT / l) and by implementing it as an input item into the simulation – more genuine picture was brought about due to the fact that home-made brandies are usually not easy to sell. Therefore, farmers in general sell home produced brandy at lower prices. The existing tax legislation also precludes farmers from more aggressive marketing approach regarding the sale of home produced brandy.

Table 1. Plum brandy production enterprise budget with sensitivity analysis.

1000 kg of fruit mass	(plum)			
Brandy output =	118 l			
	kg, hour, l, piece,m³	SIT/kg, l piece, hour	SIT	%
Material				
gas -10 kg bottles	4.78	2100	10034	11.23
water	1.00	46	46	0.05
distillate water	4.09	517	2114	2.37
Labour				
human labour	121.56	402	48865	54.68
tractor labour	2	1600	3200	3.58
Energy				
electric power (mixer)	0	16	0	0.00
Fixed costs				
depreciation of barrels			1000	1.12
depreciation of the still			5000	5.60
depreciation of the mixer			3600	4.03
Tax			15500	17.35
TOTAL COSTS			89360	100
Break even price =	757.29	SIT / l	=	3.49 EURO*
Break even yield** =	89.36	L		
Sensitivity analysis:		Price	(SIT / l)	
	800	1000	1200	1500
Financial result (SIT)	5039	28639	52239	87639
Financial result (EURO)	23.23	132.04	240.84	404.05

* exchange rate as valid on average in 2001
** break even yield calculated at price = 1000 SIT / l

The highest prices can be achieved in the case of producing the William's pear brandy ("viljamovka"). Table 4 shows financial result at different prices for William's pear brandy. The Excel spreadsheet model facilitates the conduction of many simulations. Accordingly, the impact of family members and sugar adding to the fruit mass on the net financial result was estimated. It should be especially pointed out here that the model was made under the assumption that all technological stages actually occurred. Some farmers, however, tend to avoid certain technological stages. The process of stones removing can be omitted in plum brandy production, providing that less than 5% of stones are crushed in barrel (the stone must not be crushed to render possible the extraction of the HCN acid) and that distillation begins immediately after alcoholic fermentation has been completed. In such a way, the costs of human labour can be diminished substantially, whereas lowering the costs should clearly not affect the brandy quality in any way.

A number of family members has a bearing on the financial result gained in brandy production (since the home consumption is proportional to the number of family mem-

Table 2. Peach brandy production enterprise budget with sensitivity analysis.

1000 kg of fruit mass	(peach)			
Brandy output =	82.6 l			
	kg, hour, l, piece,m3	SIT/kg, l piece, hour	SIT	%
Material				
gas -10 kg bottles	4.78	2100	10034	13.59
water	1.00	46	46	0.06
distillate water	2.86	517	1480	2.00
Labour				
human labour	106.56	402	42837	58.01
tractor labour	2	1600	3200	4.33
Energy				
electric power (mixer)	0	16	0	0
Fixed costs				
depreciation of barrels			1000	1.35
depreciation of the still			5000	6.77
depreciation of the mixer			3600	4.88
Tax			6650	9.01
TOTAL COSTS			73845	100
Break even price =	894.02	SIT / l	=	4.12 EURO*
Break even yield** =	73.85	L		
Sensitivity analysis		Price	(SIT / l)	
	800	1000	1200	1500
Financial result (SIT)	-7765	8757	25274	50054
Financial result (EURO)	-35.8	40.36	116.52	230.77

* exchange rate as valid on average in 2001

** break even yield calculated at price = 1000 SIT / l

Table 3. Pear brandy production enterprise budget with sensitivity analysis.

1000 kg of fruit mass	(pear)			
Brandy output=	82.6 l			
	kg, hour, l, piece,m3	SIT/kg, l piece, hour	SIT	%
Material				
gas -10 kg bottles	4.78	2100	10034	14.23
water	1.00	46	46	0.07
distillate water	2.86	517	1480	2.10
Labour				
human labour	98.22	402	39485	56.00
tractor labour	2	1600	3200	4.54
Energy				
electric power (mixer)	0.8	16	13	0.02
Fixed costs				
depreciation of barrels			1000	1.42
depreciation of the still			5000	7.09
depreciation of the mixer			3600	5.11
Tax			6650	9.43
TOTAL COSTS			77158	100
Break even price =	853.62	SIT / l	=	3.93 EURO*
Break even yield** =	70.51	l		
Sensitivity analysis		Price	(SIT / l)	
	800	1000	1200	1500
Financial result (SIT)	-4428	12091	28611	53391
Financial result (EURO)	-20.41	55.75	131.90	246.16

* exchange rate as valid on average in 2001

** break even yield calculated at price = 1000 SIT / l

bers). Fig. 1 shows different financial results, given different number of family members. The prevailing tax legislation clearly benefits the farmers with bigger families. With an increase in the number of family members, the home consumption allowed (acknowledged) and net financial results gained increase linearly until a certain point, where the actual home consumption equals the brandy output reached. After attaining this point, the net financial result becomes constant (horizontal line in the Fig. 2). It must also be stressed here that tax collectors do not conduct stringent control over the home brandy production.

Sugar can also be added to fruit mass (after mixing) in order to increase brandy output. Table 5 shows the effect of different amounts of sugar added on the total brandy output, total costs and the net financial result earned.

The simulation demonstrates that the highest financial result can be expected in plum brandy. Although the brandy outputs made of pear and peach are nearly equal (depending upon the sugar percentage content by individual pear and peach varieties), the financial result coming from pear brandy production is still higher. This is due to the lower costs incurring in pear brandy production, since mixing of pears is conducted using the machine, while the process of removing the stones from peaches is conducted manually. Sugar adding directly contributes to higher financial results but, on the other hand, also increases the tax costs because the difference between brandy produced and home consumption acknowledged becomes larger. The costs of sugar added accounts merely from 1.11% (0.5 kg of sugar added / 100 kg of fruit mass) to 4.30% (4 kg sugar added / 100 kg

Table 5. Total brandy output, total costs and financial result at different amounts of sugar added (calculated at the brandy price p_y = 1200 SIT / l).

	Plum	Brandy		Peach	Brandy		Pear	Brandy	
Sugar added kg/100kg of fruit	Brandy Output (kg)	Total costs (SIT)	Fin. result (SIT)	Brandy Output (kg)	Total costs (SIT)	Fin. result (SIT)	Brandy Output (kg)	Total costs (SIT)	Fin. result (SIT)
0.0	118.0	89360	28639	82.6	73847	8757	82.6	77158	12091
0.5	123.9	91751	32148	88.5	76236	12263	88.5	72899	15600
1.0	129.8	94141	35658	94.4	78627	15272	94.4	75290	19109
1.5	135.7	96532	39167	100.3	81018	19281	100.3	77680	22619
2.0	141.6	98923	42676	106.2	83408	22791	106.2	80071	26128

Table 4. Financial result of William's pear brandy production.

Price (SIT / l)	Financial result (SIT)	Financial result (EURO)*
1500	53391	246
1800	78171	360
2000	94691	436

* exchange rate as valid on average in 2001

Source: Rozman (2001)

of fruit mass) of the total costs. For instance, the tax contributed 9.43 % to the total costs of pear brandy production without sugar adding. When adding 4 kg of sugar per 100 kg of mixed fruit mass the share of the tax in total production costs increased up to 15.67% (Rozman 2001). Although sugar adding improves net financial results, it should still be done with caution. At higher sugar percentages the alcoholic fermentation in the fruit mass is namely hindered, and the brandy output ceases an upward trend.

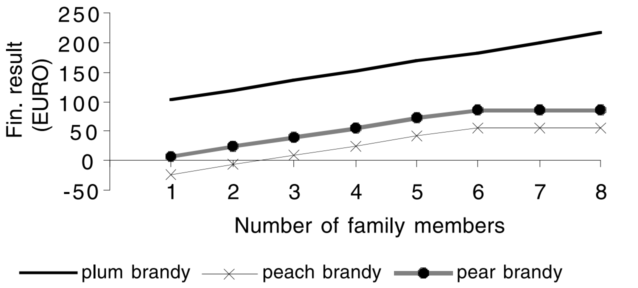

Fig. 2. Financial result of brandy production at different numbers of family members (square = peach brandy, triangle = pear brandy, the highest line = plum brandy).

CONCLUSIONS

A static simulation model was developed in this study to enable a comparative cost analysis in brandy production. The study shows that brandy production could be economically viable under the assumption that break-even prices are achieved. The brandy production could considerably enrich (diversify) the supply of different agricultural produce within a particular farm. As such, brandy production could be perceived as an ideal (farm commodity) in cases when family households are entangled in farm tourism. A big variety of options in brandy processing remains at the disposal for rather numerous Slovene brandy producers (different kinds of liqueurs). Consequently, it is acknowledged that the model developed here represents a suitable farm management technique which can be used as a decision support tool for a vast majority of Slovene farmers involved in home fruit processing activities.

However, the main obstacles lying ahead in fruit brandy production, thus, preventing it from being really viable farm strategy (option) in Slovene circumstances, are the insufficient (vague) legislation and a strong competition on the part of several other popular strong alcoholic beverages (whiskey, vodka, etc.). It is our belief that in this light, at least, the legislation regarding the alternative production on farms (e.g., home fruit processing) should be enacted effectively and promptly.

To strengthen further this standpoint, it must be noted here that the tax legislation and legislation on alternative farm production was already subject to change in year 2001. The model for tax computation was namely changed to fixed sum of 3.000 SIT, which must be paid by every registered owner of distil device. In this light, it is undeniable fact that regardless using the same methodology, the results for year 2001 would be somewhat different.

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Received May 5, 2001; Accepted in final form October 30, 2001