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OPERATION EFFICIENCY IN THE FRUIT PRODUCTION CHAIN – A STUDY BASED ON REAL CASES

EFEKTYWNOŚĆ OPERACJI W ŁAŃCUCHU PRODUKCJI OWOCÓW – BADANIA OPARTE NA RZECZYWISTYCH PRZYPADKACH

Key words: apple, fruit, postharvest, economic efficiency, producers' organizations

Słowa kluczowe: jabłka, owoce, obróbka po zbiorach, efektywność ekonomiczna, organizacje producentów

Abstract. In our study, by simulating the model of an apple producing firm, we investigated how the availability of postharvest establishments influences the economic efficiency of production. The results of our analysis highlighted the fact that by possessing cold storage and introducing an extended selling period, a producing enterprise may make higher profits (NPV) of 40 to 50% during the lifetime of the investment than if without such postharvest mechanisms. In the investigated case, however, because of the huge capital requirement at the beginning, the internal rate of return (IRR) was somewhat unfavourable. However, in the case of own, ready and running postharvest establishments, better investment economic efficiency parameters (from 40 – 120 %) may be reached. Thus the capital need for investment is much lower for the producing enterprise, but the price advantage of the extended selling period remains.

Introduction

Fruit production has a highlighted role in the agriculture of Hungary, which is proved by the fact that it employs a significant number of workers, fixes assets in billions of HUF, and accounts for 8 to 10% of the production value of plant production [Kiss 2003]. The apple production has been decreasing in Hungary which had 41000 hectares of apple plantations in the year of 2000. By now, Hungary has only 26000 hectares cultivated to produce apple. These plantations are characterized by different management levels resulting in very volatile apple yields, which range between 300 000 and 800000 tons per year, causing low or critical profitability for the vast majority (80%) of apple producers [Fruitveb 2013]. In the fruit industry selling prices have decreased or stagnated over the the last years, selling safety has become hectic and producing enterprises have to perform better and better so that production becomes economically efficient [Lakner-Apáti 2010]. One of the tools for improving economic efficiency is to increase the standard of postharvest processes, especially in through cold storage thanks to which the time of selling may be extended and the average selling prices may be significantly improved. Many reserves are hidden in enhancing the producers' organizational level, where producers jointly use the postharvest infrastructure having high capital requirement much cheaper [Hofmann 2009, Doluschitz 2001, Möhring et. al. 2007].

There are organisational defects and failures in general in Hungary, which are still not killing factors. Yet, these factors might be killing ones from strategic point of view, just like the size issue. There is no generally right size of operation (economies of scale), but all organisations must be aware of the huge differences that exist among competitors in specific sectors [Felföldi 2009]. Because of the reasons mentioned above our major objective in our present study is to answer the following questions:

– does the postharvest infrastructure with special regard on the availability of cold store capacities improve the economic efficiency of producing enterprises?
– do postharvest establishments developed by producing enterprises or the communal investments of producers' sales organizations (PSO) make the activity of producing enterprises more effective?

Our hypothesis is the fact that the availability of own producing cold store capacities improves the efficiency of the operation of producing enterprises. However, having postharvest establishments in community ownership enhances the producers' organizational level and improves the economic efficiency of producing enterprises in a more effective way than establishing own producing postharvest investments.

Research material and methodology

Static and dynamic analyses constitute the two major methods of investment economic efficiency analysis. Dynamic methods provide more valid results and they differ from static methods in the fact that they include the time value of money [Graham 2001, Kruschwitz 2009, Warren 1982]. There are several indicators for dynamic investment analysis, from which NPV (Net Present Value), DPP (Discounted Payback Period), IRR (Internal Rate of Return, return on capital) and PI (Profitability Index) are calculated [Flock 2000, Brealey et al. 2006].

The central element of the method of investigation is simulation modelling based on gathering mainly primary data, focusing on natural inputs and yields in producing firms and on gathering secondary data gathering in a small ratio. To carry out the examinations, similarly to Szőllősi [2008] work, a deterministic simulation model was compiled whose input data were technological elements on one hand and economic parameters on the other. The utilized dynamic investment economic efficiency indicators are the following: NPV, IRR, DPP, PI.

The return on capital of the alternative investment that is the expected, minimal capital requirement of the fixed capital is expressed by the calculative interest rate (r), the ratio of which is 7% in the calculations. The interpretation of the above mentioned indicators is summarized in Table 1.

In our model an apple orchard with an intensive operating system cultivated at a high standard and in good condition is considered. The parameters of the characterized orchard type are the following: M9 rootstock, slender spindle crown form, spacing of 4.0 x 1.0 meters, 2 500 trees per one hectare, drip irrigation, a yield level of 40 to 50 tons per hectare in a normal year, from which 85% constitute products for eating, while the ratio of apple for industrial purposes is 15%. The apples for eating are of first class (without sorting and packing).

In the model a good production standard and high technological discipline are taken into consideration. The calculations refer not to the national average but to up-to-date firms producing

Table 1. The interpretation of the utilized dynamic investment economic efficiency indicators at the end of the lifetime of the investment (15 years)
Tabela 1. Interpretacja wykorzystania wskaźnika dynamiki inwestycji efektywności ekonomicznej na koniec okresu istnienia inwestycji (15 lat)

Denomination/*Denominacja*	The investment is economically efficient/ *Inwestycja ekonomicznie wydajna*	Turning point of economic efficiency/ *Punkt zwrotny efektyewności eknomicznej*	The investment is not economically efficient/ *Inwestycja ekonomicznie niewydajna*
Net Present Value of Profit (NPV)/*Wartość bieżąca netto zysku*	> 0	= 0	< 0
Internal Rate of Return (IRR)/*Wewnętrzna stopa zwrotu*	> r	= r	< r
Discounted Payback Period (DPP)//*Okres zwrotu inwestycji zdyskontowanych*	< t	= t	> t
Profitability Index (PI)/*Wskaźnik rentowności*	> 1	= 1	< 1

Note: r = calculative interest rate = 7%,, t = lifetime of the investment = 15 ye*ars/Uwaga: r = obliczeniowe oprocentowanie = 7%, t = czas życia inwestycji = 15 lat*
Source: own study
Źródło: opracowanie własne

at a good standard. The prices and prime costs of the used inputs (materials, labour, mechanical work) reflect the price standards of the years 2012 to 2013. The prices of materials were considered without VAT, the wages were calculated altogether with benefits. Selling prices are represented by a longer-term average (5 years).

Research Results

To investigate the questions set in our objectives three different enterprise models were compiled:

1. Model A: the producing enterprise has only an orchard, postharvest infrastructure does not belong to production. The products are sold directly after the harvest. The main characteristics of the model are the relatively low capital requirement at the beginning, because of these conditions, but smaller realized profit due to the lower selling prices during autumn.
2. Model B: the producing enterprise establishes postharvest infrastructure (cold storage) besides the orchard, which results in a very high capital requirement at the beginning, a much higher average selling price and by this a higher profit in the years of the operation.
3. Model C: the producing enterprise establishes only an orchard; the cold store is realized by the producers' sales organization (PSO) and the organization has it operated. The main characteristics of this model from the aspect of the producing enterprise is the low startup capital requirement, but a much higher annual operational cost in the years of the operation, as well as a high selling price and a relatively high annual profit similar to model B.

In the investment economic efficiency model the calculations were carried out at present prices. In this way inflation was not considered either in the case of output or input-sided markets. Depreciation was not calculated among the expenses. The investment cost (C_0) constituted the settlement cost of the orchard as well as the establishment cost of the cold storage (ULO-storage). A storing capacity of 25 tons per hectare was planned for an average yield of 40 tons from one hectare orchard surface, as the apple quantity exceeding this is sold in autumn without storage. The investment costs of the machinery necessary for the cultivation of the orchard were not calculated among the investment costs, because these costs are considered to already exist.

The results of model A are illustrated in Table 2. In this case the investment cost comes from the establishment of a new, intensive apple orchard having the parameters already mentioned, which totals up to 4 500 to 5 000 thousand HUF per hectare (the settling happens with one year old grafts and there is not any hail netting on the orchard). The first three years constitute the period of turning to productive state. In the first year, there is not any yield taken into consideration, while in the second year a yield of 10 tons per hectare may be calculated. The orchard reaches the period of the whole products in the fifth year, from which it produces a yield of approximately 40 tons per hectare in the average of many years. From this amount 85% is for eating while 15% is used for industrial purposes.

Regardless of the investment of a cold store, selling of the products happens in the period of harvesting (August-November). At this time there is a significant oversupply in the Hungarian ap-

Table 2. The annual tendencies of yields and cash flows in model A
Tabela 2. Roczne zmiany plonów i przepływów pieniężnych w modelu A

Years/ *Lata*	Yield/ *Plon [t/ha]*	Average selling price/ *Średnia cena sprzedaży*	Revenue/ *Dochód*	Expense/ *Koszty*	Net cash flow/ *Przepływy pieniężne netto*
		HUF/kg/ *forinty/kg*	thous. HUF/ha/*tys. forintów/ha*		
0.	0.0	50.0	0	4 800	-4 800
1.	0.0	50.0	0	250	-250
2.	10.0	50.0	500	400	100
3.	22.0	50.0	1.100	700	400
4.	35.0	50.0	1.750	1 000	750
5-15.	40.0	50.0	2000	1 050	950

Source: own study
Źródło: opracowanie własne

Table 3. The annual tendencies of yields and cash flows in model B
Tabela 3. Roczne zmiany plonów i przepływów pieniężnych w modelu B

Years/ *Lata*	Yield/ *Plon [t/ha]*	Average selling price/ *Średnia cena sprzedaży*	Revenue/ *Dochód*	Expense/ *Koszty*	Net cash flow/ *Przepływy pieniężne netto*
		HUF/kg/ *forinty/kg*	thous. HUF/ha/*tys. forintów/ha*		
0.	0.0	80	0	11 550	-11 550
1.	0.0	80	0	250	-250
2.	10.0	80	800	450	350
3.	22.0	80	1 760	800	960
4.	35.0	80	2 800	1 130	1 670
5-15.	40.0	80	3 200	1 200	2 000

Source: own study
Źródło: opracowanie własne

ple market, thus the achievable average selling prices are about 50 HUF/kg. As a result, about 2 000 thousand HUF per hectare of revenue may be achieved in an average productive year. The annual operational cost of producing a yield of 40 tons per hectare (regardless the depreciation cost) is 1 000 to 1 100 thousand HUF per hectare. As a result, the cash flow of an average productive year is 950 thousand HUF.

Regarding "*Model B*" in Table 3 even the establishing cost of the cold store is calculated besides the settlement cost of the orchard among the investment costs of the 0th year. It equals 6 750 thousand HUF projected to a storage capacity of 25 tons per hectare, which is a starting capital requirement of 11 550 HUF per hectare altogether with the orchard. The major effects of the cold store investment on the result of one productive year will be the followings:

– The yield does not change, the average selling prices increase to 80 HUF/kg regarding the fact that yields of 25 tons per hectare are sold during spring. The output product is of first class apple for eating purposes in bins, without sorting and packing. Altogether a revenue of 3 200 thousand HUF/hectare may be realized.
– The annual expenses increase only by 150 thousand HUF compared to "Model A", because approximately only 150 thousand HUF of the total cost of 650 thousand HUF per hectare of the cold storage is annual operating cost, the remaining 400 thousand HUF is the depreciation cost of cold storage, which is not considered as an expense.
– As a result of the above mentioned, the net cash flow reached in an average productive year will be twice as much as the value in model A (2 000 thousand HUF/hectare).

Table 4 contains the results of model C, where the producers' organization carries out the storage and the selling. The realizable revenues equal those of model B, because of the same yield and selling conditions. The difference appears in the following:

– Only the cost of settling the orchard must be calculated among the investment costs, as establishing the cold store is carried out by the producers' organization (regardless of the fact that investments of bigger capacities are generally cheaper per unit). Thus, the starting capital requirement of the producing enterprise is much smaller than that in model B.

Table 4. The annual tendencies of yields and cash flows in model C
Tabela 4. Roczne Roczne zmiany plonów i przepływów pieniężnych w modelu C

Years/ *Lata*	Yield/ *Plon [t/ha]*	Average selling price/ *Średnia cena sprzedaży*	Revenue/ *Dochód*	Expense/ *Koszty*	Net cash flow/ *Przepływy pieniężne netto*
		HUF/kg/ *forinty/kg*	thous.HUF/ha/*tys. forintów/ha*		
0.	0,0	80.0	0	4 800	-4 800
1.	0.0	80.0	0	250	-250
2.	10.0	80.0	800	550	250
3.	22.0	80.0	1 760	1 100	660
4.	35.0	80.0	2 800	1 750	1 050
5-15.	40.0	80.0	3 200	1 800	1 400

Source: own study
Źródło: opracowanie własne

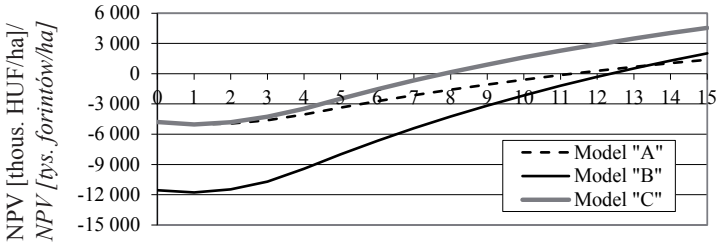

Figure 1. The Tendency of the NPV during the lifetime of the investment in the three models
Rysunek 1. Tendencja NPV w trakcie trwania inwestycji w trzech modelach
Source: own study
Źródło: opracowanie własne

– The annual expenses, on the other hand, are much higher, as the total per hectare cost (approximately 650 thousand HUF/hectare) of the cold storage is paid by the producer for the organization; furthermore, a per hectare contribution of 100 thousand HUF was calculated.
– The result of the above fixed conditions will be the fact that the annual cash flows will range between the values of the models A and B.

On the basis of the results above, the fastest payback period and the biggest NPV may be expected from "Model C", the payback periods of "Models A" and "B" are almost the same, but higher NPV may be reached by 40 to 50% in "Model B" (*Figure 1*).

Table 5 summarizes the investment economic efficiency indicators of the three examined models. We concluded that in the case of every indicator, "Model C" reflected the best results, thus the absolute profit volume (NPV), the return on capital (IRR, PI) and even the payback period are the best in this case. The value of the NPV is twice as much and three times higher than the values of the other two models, the return on capital is more favourable by 60 to 70% and the payback period is expected 4 to 5 years earlier.

When comparing models A and B, it must be highlighted that "Model B" shows more favourable values by 10 to 15% relating to the aspects of return on capital because of the huge capital requirement at the beginning, but it performs better by 40 to 50% (regarding the absolute profit volume) than model A.

As a consequence, the postharvest investments significantly improve the economic efficiency of production, especially in the case when they are realized in the form of community investments within the frame of producers' organization. In connection with our results, attention must be drawn to the fact that calculable factors determining economic efficiency were built in the model; other factors, which could not be calculated or could hardly be calculated were not taken into consideration, which may modulate our final consequences. The practical experiences, however, strengthen the validity of our calculation in order of magnitude.

Table 5. The tendencies of investment economic efficiency indicators in the three examined models
Tabela 5. Tendencje wskaźnika inwestycji efektywności ekonomicznej w trzech badanych modelach

Denomination/*Denominacja*	Unit/*Jedn.*	Model A	Model B	Model C
Net Present Value of Profit (NPV)/*Wartość bieżąca netto zysku*	thous. HUF/ha/ *tys. HUF/ha*	1 387	2 021	4 533
Internal Rate of Return (IRR)/*Wewnętrzna stopa zwrotu*	%	10,22	9,09	16,19
Discounted Payback Period (DPP)//*Okres zwrotu inwestycji zdyskontowanych*	years/*lata*	12	13	8
Profitability Index (PI)/*Wskaźnik rentowności*	-	1.29	1.17	1.94

Source: own study
Źródło: opracowanie własne

Conclusions

The results of our analysis revealed the fact that in the case of own cold storage and an extended selling period a producing enterprise may realize a higher NPV of 40 to 50% (during the lifetime of the investment) than without postharvest. In this case, however, because of the huge capital requirement at the beginning, the internal rate of return (IRR) is somewhat more unfavourable than if the products from the orchard had been sold right after harvesting without postharvest. In the case of own postharvest establishments, better investment economic efficient parameters may be reached by 40 to 120%, if the producers' organization sets up the postharvest establishments and the organization has them operated, thus the capital need of the investment is much lower for the producing enterprise, but the price advantage of extended selling remains. All these facts draw attention to the fact that well operating producers' organizations may improve the efficiency of producing enterprises.

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Streszczenie

Zbadano, jak dyspozycyjność placówek po zbiorze wpływa na ekonomiczną wydajność produkcji. Do analizy użyto modelu firmy produkującej jabłka. Stwierdzano, że posiadanie chłodni oraz wprowadzenie przedłużonego okresu sprzedaży powoduje, że firma podczas całego okresu trwania inwestycji osiąga większe o 40-50% zyski (NPV) niż firma nieposiadająca tego typu mechanizmów po zbiorze. W badanej firmie jednak z powodu ogromnego zapotrzebowania na kapitał początkowy wewnętrzna stopa zwrotu (IRR) nie była korzystna. Niemniej jednak, w przypadku własnej, wyposażonej i działającej placówki po zbiorze, mogą zostać osiągnięte lepsze parametry ekonomicznej wydajności (od 40 do 120%). Wtedy kapitał potrzebny do inwestycji w firmę produkcyjną jest dużo niższy, a korzyści finansowe płynące z wydłużonego okresu sprzedaży pozostają takie same.

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