

Short thesis for the degree of Doctor of Philosophy (PhD)

**ECONOMIC ANALYSIS OF HUNGARIAN
INDUSTRIAL APPLE AND APPLE JUICE
CONCENTRATE PRODUCT PATH**

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1 PRECEEDINGS, OBJECTIVES AND INTRODUCTION OF RESEARCH HYPOTHESES

Apple juice concentrate (AJC) is a processed product of great global significance. Hungary is among the top 10 apple juice concentrate producer of the world, and AJC is the 3rd leading export product of our fruit and vegetable processing industry. Apple is the dominant sector of the Hungarian fruit production with its production area of 26 thousand hectares. Hungary is ranked among the top 20 apple producing countries of the world, however, 40% loss in domestic production area could have been observed in the past 15 years. In a unique manner, 4,000 hectares of specialized industrial orchards have been established in the past 20 years in Hungary in order to provide raw material for apple juice concentrate production, these plantations currently make up almost 15% of domestic apple orchards.

Based on the data of Hungarian Central Statistical Office (KSH) the domestic average apple yield has been 15.6 t/ha in the period between 2010 and 2013 that lags behind by as much as 60% of that of good standard domestic yields, thus production is underdeveloped. According to the orchard census of KSH (2013)¹ 54% of apple orchards are 15 years old or above, and 28% of the plantations are 25 years old or above. These orchards are genetically incapable of producing quality products. According to GONDA – APÁTI (2012)² only the forced maintenance of supports could have conserved those decrepit, untended, uncompetitive orchards until these days, and these plantations are capable only for the production of industrial quality apples. The question must be raised that in case these supports are going to become stricter, decrease or cease, then these low-standard, extensive or decrepit, untended orchards would be managed further or not, and would these produce any kind of products in the future. In case in the lack of supports the revenues from industrial apple does not cover the costs, then no raw material is going to be received by processing

¹ KSH (2013): Alma-, körte-, kajsz- és őszibarack ültetvények adatai, 2012. (Data on apple, pear, apricot and peach orchards in 2012). Editor: Gábor Valkó. Központi Statisztikai Hivatal (Hungarian Central Statistical Office). Statisztikai Tükör. 49 p.

² Gonda I. – Apáti F. (2012): Az almaágazat múltja, jelene és jövőbeni kilátásai. (Past, present and future prospects of the apple sector). Agrofórum, 23. évf. 43. sz. pp. 7-13.

industry from these plantations (the apple will not even be harvested), and if the establishment of new dessert apple orchards will not be conducted, then the supply of processing industry capacity is going to be jeopardized. Since 80% of these capacities are owned by companies in foreign ownership (and these companies possess processing plants in many other regions of the world) it is quite possible that due to insufficient raw material supply they will simply leave the country, and processing industry capacity remains only for a fraction of industrial apple quantity produced. The issue of industrial apple price is double-sided: low industrial apple prices are jeopardizing the rentability of production, while high industrial apple prices put processing in hazard. The current state of the industrial apple - apple juice concentrate product path struggling with hardships and problems cannot be maintained for long, but due to the uncertain future it is inevitable to gain thorough knowledge about the situation of the participants of the product path in order to elaborate rentable raw material production, reliable raw material supply, competitive processing, thus creating an operational product path.

Economic analysis of the domestic apple sector has been conducted by many researchers with special regard to the economic evaluation of dessert apple orchards, and economic examination of technological elements increasing intensity, decreasing weather related risks or associated with postharvest processes. However, the farm economic analysis of domestic industrial apple production has not yet been done, and the number of foreign examples is quite scarce, since the specialized industrial apple orchards are almost exclusively characteristic for Hungary. Economic evaluation of processing industry has been conducted only in several areas of food industry, no domestic or foreign studies are available about the economic analysis of apple juice concentrate production.

In my thesis, I volunteered precisely because of the reasons detailed above to conduct a thorough economic evaluation of industrial apple production and apple juice concentrate production. The analysis of the product path can serve as an aid to explore the reasons standing behind the problems of the sector, to draw tendencies that can be expected on a long term, and may contribute to solve the functional disturbances of the product path. Results can be utilized by each market participants and for the decision makers of the sector.

My primary objective is to conduct a domestically representative economic analysis of apple juice concentrate production, and to evaluate the rentability and efficiency of raw material production; and based on these to determine the cost-profit distribution of this product path and to simulate the development tendencies that can be expected after 2020.

Regarding the cluster of problems detailed above, my **research objectives** are as follows:

1. Is the Hungarian industrial apple production economically viable on the specialized industrial plantations? What profitability indicators are characteristic for raw material production depending on the level of supports?
2. What is the profitability of domestic apple juice concentrate production on sectorial level, farm level and in different years:
3. Does Hungary have a comparative advantage on the global market of apple juice concentrate?
4. How are costs and profit distributes in the industrial apple-apple juice concentrate product path segment?

Regarding the objectives above, my hypotheses are as follows:

H1 – *Specialized industrial apple plantations in Hungary are not capable of economically viable industrial apple production, these plantations are maintained just from supports.*

H2 – *Profitability of the apple juice concentrate production in Hungary is positive even in the case of high raw material prices (industrial apple prices).*

H3 – *Apple juice concentrate produced in Hungary does not possess a competitive advantage on the global market.*

H4 – *Majority of the profit generated on the industrial apple-apple juice concentrate product path is deposited in the processing industry, and processing industry has more favourable profitability indicators than that of production.*

Tasks aligned to research objectives:

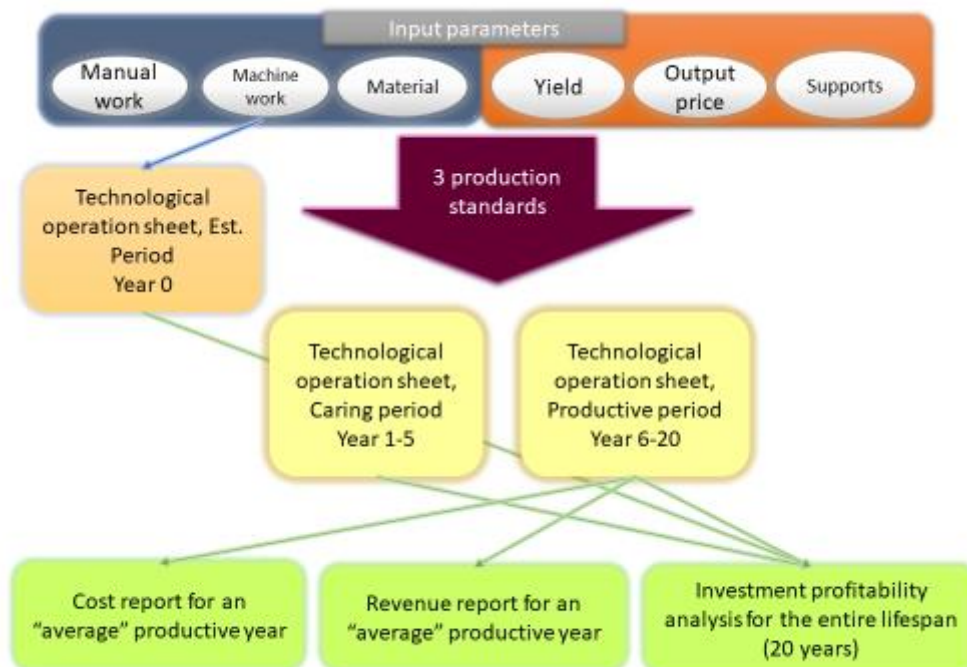
1. Evaluation of the relation system of Hungarian industrial apple production and processing, exploration of the Hungarian peculiarities of industrial apple production. Evaluation of the level and structure of natural inputs, production costs, yields and production values from investment through growing period until productive age. Analysis of the results and efficiency of production (cost-benefit analysis), and conduct of investment rentability analysis on the entire lifespan of the plantation with sensitivity analyses.
2. Analysis of processing's level and structure of natural inputs, production costs, and examination of output and production value. Analysis of the results and efficiency of processing (cost-benefit analysis) with sensitivity analyses.
3. Mapping of the apple juice concentrate world market, determining market concentration and evaluation of the comparative advantages of Hungarian apple juice concentrate based on production and foreign trade data with descriptive statistics, HHI-index and RCA index group, and the time series analysis of the price of apple juice concentrate.
4. Based on the analyses detailed above, conduct of cost-benefit analyses on different levels: product path and sector level.

2 DATABASE AND APPLIED METHODS

Creation of a self-made, custom database was necessary for the analysis of producing and processing enterprises, thus the entire product path.

Results of the examinations on raw material production cannot be considered representative due to the number of data providing enterprises, however, based on consultations with professional consultants and project leaders it can be stated that with regard of order of magnitude they give a true representation of farm economic characteristics of industrial apple production. The dataset that should have been collected to be able to conduct farm economic analysis in order to give a farm economy analysis of the entire sector consists of the following variables:

- Establishment costs,
- Yields realized in the period of fruiting, selling prices, available supports and production costs (natural inputs, input prices),
- Yields realized in the full productive period, selling prices, available supports and production costs (natural inputs, input prices).



Source: Own edition based on Apáti (2007)

Figure 1: Structure of the raw material production model

Collected data were compiled in an Excel-based deterministic simulation model that was based on models used in studies by APÁTI

(2007)³ and SZABÓ (2016)⁴. Structure and operation of the applied model is shown by *Figure 1*. The model is capable of the complex evaluation of the raw material production side's cost-revenue situation, and running of an investment rentability analysis on the entire lifespan of the plantation.

Enterprises included in the study cover 80% of processing plants and 90% of processing capacity, therefore my analysis on domestic processing industry can be considered as representative. In the course of conducting the analysis my primary objective was to evaluate the economic characteristics of domestic apple juice concentrate production on a sector level by conducting factory level cost-revenue analysis of the domestic processors. In order to achieve this, I made the cost-revenue analysis of processing for the period between 2013 and 2015 on factory level.

For the evaluation of the economic characteristics of apple juice concentrate production the collection of the following data were necessitated:

- Quantity, quality and purchase price of processed industrial apple
- Natural technological parameters associated with processing
- Costs associated with the raw material
- Fix and variable costs of processing (production)
- Selling prices realized in the period of selling

Table 1 shows the objective, data requirement and data sources of processing of secondary databases going beyond primary farm economic data collection-

³ Apáti F. (2007): A jó színvonalú magyar és német almatermesztés összehasonlító gazdasági elemzése. (Comparative economic analysis of Hungarian and German apple production of good standards. PhD dissertation. Debrecen. 149. p.

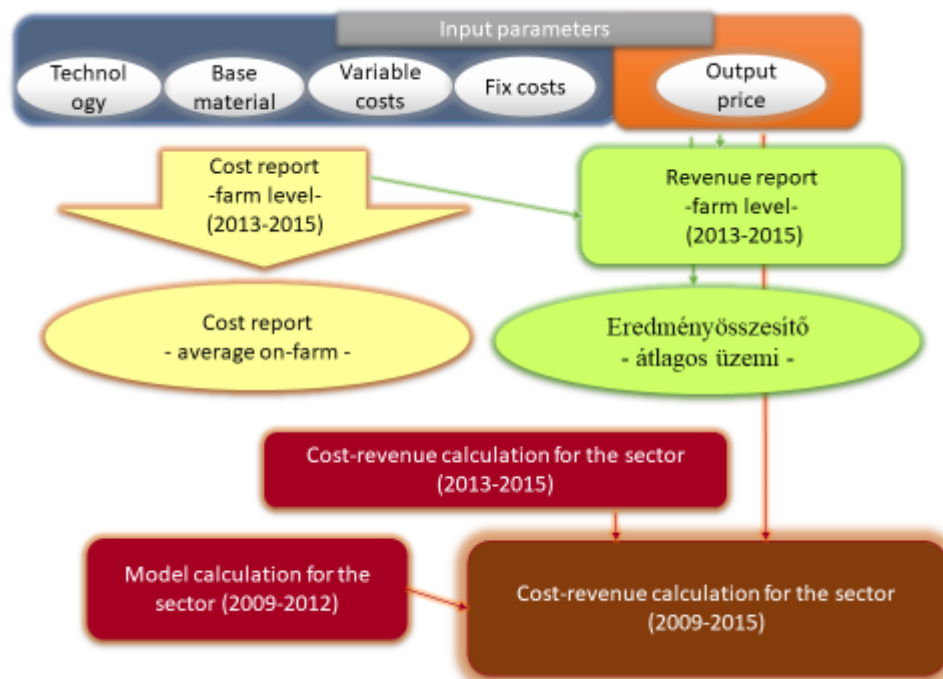
⁴ Szabó V. (2016): Az almatermelés hatékonyságnak alakulása az intenzitás növelése és a műszaki fejlesztések függvényében. (Efficiency of apple production depending on increasing intensity and technical developments). PhD dissertation. Debrecen. 140. p.

Table 1: Data requirement of secondary analysis

Objective	Data requirement	Source
Determining the comparative advantage of domestic apple juice concentrate on the world market.	Annual export and import figures of apple juice concentrate in each and every apple juice concentrate producing country in the world in the period between 2002 and 2015.	COM-TRADE
Quantification of world market concentration of apple juice concentrate.	Annual export volume of each and every apple juice concentrate producing country in the world in the period between 2002 and 2015.	
Time series analysis of the volume of apple juice concentrate exported from Hungary.	Exported volume and value of domestic exported apple juice concentrate in the period between 2010 and 2016 in monthly figures.	
Time series analysis of the price of apple juice concentrate exported from Hungary and making a prognosis.	Average export price of domestic apple juice concentrate in the period between 2010 and 2016 in monthly figures.	
Measurement of strength and direction of relations between factors affecting the price of apple juice concentrate	Apple production in the World, European Union and Hungary in the period between 2002 and 2015.	USDA, WAPA
	Annual Hungarian average industrial apple prices in the period between 2002 and 2015.	KSH (Hun. Central Statistical Office)
	Annual Hungarian average industrial apple juice concentrate prices in the period between 2002 and 2015.	COM-TRADE
	Prime cost of concentrate produced in Hungary in the period between 2009 and 2015.	My own, custom database
	Monthly average prices of apple and orange juice concentrates in the period between 2010 and 2015.	COM-TRADE

Source: own editing

I compiled the collected data in an Excel-based deterministic simulation model. Structure and operation of the model is shown by *Figure 2*. This model can be considered as a hybrid, since utilized data came from both primary and secondary sources.



Source: own editing

Figure 2: Structure of the processing model

The data necessary for the analysis of the entire product path were provided by results of raw material production and processing. Results represent 4000 ha of specialized industrial plantation and the concentrate made from the raw material produced in this area (as industrial apple-apple juice concentrate product path) and not the whole processing capacity. Results are presented by production standards and sector level as well.

For conducting the analysis, the comparison of the following data was necessary:

- production costs of raw material production, production value and net income per production standard levels,
- Detailed statistics on the allocation of supports,
- production costs of processing, production value and net income,
- Basic data required to calculate these data for 1 ha, 1 kg concentrate and 1 kg industrial apple.

Applied methods and their justification are summarized in *Table 2*.

Table 2: Summary of applied methods

Method	Justification/area
Cost-benefit analysis	Evaluation of cost-revenue characteristics of raw material production.
	Evaluation of cost-revenue characteristics of processing.
Investment profitability analysis	Evaluation of rentability for the entire lifespan of raw material producing orchards.
Sensitivity analysis	Evaluation of external and internal environmental and market effects impacting raw material production.
	Evaluation of external and internal environmental and market effects impacting processing.
Critical value analysis	Determination of critical values of supports, yields and farm size as a function of raw material production profitability and rentability.
Time-series analysis	Trend analysis and short-term prognosis of price and sold quantity of concentrate.
Regression analysis	Exploration of relationships between factors affecting the price of concentrate.
HHI-index	Determination of the world market concentration of concentrate.
RCA-index group	Determination of the competitiveness of Hungarian apple juice concentrate.

Source: own editing

3 MAIN STATEMENTS OF THE THESIS

My main statements in relation to objectives are as follows:

- 1. Is the Hungarian industrial apple production economically viable on the specialized industrial plantations? What profitability indicators are characteristic for raw material production depending on the level of supports?*

Based on standards and intensity of production technology (during growth and productive period) and yields three production standards can be differentiated: low, moderate and high.

Table 3: Revenues in case of different production standards with average yields

Name	Low	Moderate	High
	Production standard		
Basic data			
Total direct cost (HUF/ha)	366,078	621,118	925,011
Production cost (HUF/ha)	402,686	683,230	1,017,512
Prime cost (HUF/kg)	32.21	27.33	24.23
Operation cost (HUF/ha)	292,883	526,860	858,292
Yields (t/ha)	12.50	25.00	42.00
Revenue (HUF/ha)	306,000	612,000	1,028,160
Revenue with SAPS support			
Total revenue (HUF/ha)	376,848	682,817	1,098,935
Net income (HUF/ha)	-25,064	360	82,193
Cost-related profitability	-6%	0%	8%
Revenue with SAPS and production linked support			
Total revenue (HUF/ha)	470,083	776,052	1,192,170
Net income (HUF/ha)	68,171	93,595	175,428
Cost-related profitability	17%	14%	17%
Revenue with SAPS and AES support			
Total revenue (HUF/ha)	623,215	929,184	1,345,301
Net income (HUF/ha)	221,303	246,727	328,560
Cost-related profitability	55%	36%	32%
Revenue with SAPS, AES and production linked support			
Total revenue (HUF/ha)	716,450	1,022,419	1,438,536
Net income (HUF/ha)	314,538	339,962	421,795
Cost-related profitability	78%	50%	41%

Source: own calculation

Note: selling price of industrial apple: 24.48 HUF/kg; amount of SAPS: 70,879 HUF/ha, amount of AES: 246,367 HUF/ha, amount of production linked support: 93,235 HUF/ha

Investment cost of specialized industrial plantations is 1.5 million HUF/ha. During growth period and full productivity period only minimal inputs are typical to low production standards, while high production standard is close to ideal production technology. Raw material production in productive years can be characterized with the costs and revenues shown on Table 3 as a function of support levels.

Table 4: Main dynamic investment rentability analysis indicators of different production standards and different support levels (r = 5%, t = 20 years)

Name	Low production standard	Moderate production standard	High production standard
Investment cost (C ₀) (thHUF/ha)	1,488		
Calculative rate (r)	5%		
With SAPS support			
IRR (%)	-2.0%	0.0%	3.5%
DPP (year)	-	-	-
PI	0.36	0.34	0.77
NPV (thHUF/ha)	-955	-984	-344
With SAPS and production linked support*			
IRR (%)	6.3%	5.8%	8.3%
DPP (year)	18th	19	15th
PI	1.14	1.12	1.55
NPV (thHUF/ha)	207	178	818
With SAPS and AES support*			
IRR (%)	16.5%	14.0%	15.5%
DPP (year)	8th	10th	9th
PI	2.42	2.40	2.83
NPV (thHUF/ha)	2,115	2,087	2,727
With SAPS, AES and production linked support*			
IRR (%)	22.2%	18.7%	19.8%
DPP (year)	6th	8th	7th
PI	3.20	3.18	3.61
NPV (thHUF/ha)	3,277	3,249	3,888

Source: own calculation

Note: *Amount of SAPS: 70,879 HUF/ha, amount of AES: 246,367 HUF/ha, amount of production linked support: 93,235 HUF/ha

Based on the investment rentability analysis (Table 4) conducted on the entire lifespan of orchards (20 years) the following conclusions can be drawn:

- Establishment of a specialized industrial plantation with only SAPS support received is uneconomical (does not pay off within 20 years).
- SAPS and production coupled support is not sufficient for expected (11-12 years) payoff, results in unfavourable parameters (DPP=15-19th year, IRR=15.5-16.5%).
- Establishment of specialized industrial plantations when receiving SAPS and AES is economical (DPP=8-10th year, IRR=14.0-16.5%).
- When receiving all of the three kinds of support, payoff of specialized industrial plantation is comparable to the parameters of intense and superintense plantations, it is characterized by very favourable results (DPP=6-7 years, IRR=18.7-22.2%).
- The most favourable results were produced in every scenario by the highest production standard.

Based on my results, industrial apple on specialized industrial plantations can be economically and profitably produced *ceteris paribus* (these base parameters give 100%: support level = 0 HUF/ha, price of industrial apple = 24.48 HUF/kg; average yield is 12.5 t/ha in case of low, 25.0 t/ha in case of moderate and 42.0 t/ha in case of high production standard):

→ Profitable (annual revenues cover annual costs):

- At low production standard profitable production requires at least 7.68 HUF/kg (95,943 HUF/ha) support, or 144% of the average yield (18.0 t/ha), or at least 131% of the average industrial apple price (32.15 HUF/kg).
- At moderate production standard profitable production requires at least 2.82 HUF/kg (70,519 HUF/ha) support, or 118% of the average yield (29.5 t/ha), or at least 111% of the average industrial apple price (27.29 HUF/kg).
- High production standard is the only one where profitable production can be conducted without supports: 99% of the average yield will provide profitable production and 98% of the average industrial apple price (24.20 HUF/kg) is sufficient.

- Economically (DPP=20th year, IRR=r=5%, NPV=0 at the end of 20th year)
- At low production standard profitable production requires at least 11.67 HUF/kg (145,900 HUF/ha) support, or 208% of the average yield (26.0 t/ha), or at least 165% of the average industrial apple price (40.34 HUF/kg).
 - At moderate production standard profitable production requires at least 5.92 HUF/kg (148,100 HUF/ha) support, or 155% of the average yield (38.75 t/ha), or at least 134% of the average industrial apple price (32.79 HUF/kg).
 - At high production standard profitable production requires at least 2.33 HUF/kg (97,800 HUF/ha) support, or 122% of the average yield (51.24 t/ha), or at least 113% of the average industrial apple price (27.79 HUF/kg).

According to the graft inventory statistics of NÉBIH (2017)⁵ (National Food Chain Safety Office) 19-42% of grafts sold in recent years were resistant cultivars, which means that significant number of specialized industrial plantations had been established in the country - in some years even more than dessert plantations. The reason for this is that specialized industrial plantations have the following advantages compared to intense and superintense dessert plantations:

- The required invested capital is relatively low (1.5 million HUF/ha) compared to more intense 2.1-10.7 million HUF/ha),
- The required working capital is relatively low (293-858 thousand HUF/ha, while at more intense plantations it is 1.3-1.9 million HUF/ha),
- Despite of its 20-80% lower revenue generating capacity, at high support levels it is possible to attain more favourable cost-related profitability (by 38%) and shorter payoff period (by 2-6 years).
- Requires less labour force and professional knowledge, means lower production risk and provides a certain, stable market,
- More favourable profitability and excellent payoff at high support levels.

⁵ Nemzeti Élelmiszerbiztonsági Hivatal (2017): Oltvány leltár statisztika (2008-2013)

According to macroeconomic approach, the specialized industrial plantations are uneconomical: production is not economical even at low and high support levels.

Altogether it can be stated that with the support level currently present in the sector, low production standard plantations can be maintained on a long term, therefore the support system does not inspire the sector to increase efficiency. The relatively high support level that is characteristic to this sector significantly distorts the efficiency that can be attained clearly by market principles. Since profitability depends heavily on supports, change in support policy jeopardizes the survival of these orchards. My opinion is that by creating a support system that is shifted towards greater efficiency, low and moderate production standard plantations will give up production, only high production standard orchards will survive.

2. What is the profitability of domestic apple juice concentrate production on sectorial level, farm level and in different years?

My conclusions can be considered representative, since they are based on my analysis including 4 facilities that covered 80% of domestic processing facilities and 90% of domestic processing capacity in the period between 2013 and 2015. The prime cost of apple juice concentrate production among domestic conditions is 253.0 HUF/kg, of which raw material cost is 174.90 HUF/kg (with 24.48 HUF/kg average industrial apple price), and processing cost above raw material cost is 78.10 HUF. Processing costs above raw material cost can be divided to fix (46.15 HUF/kg) and variable (31.95 HUF/kg) costs. The average price of concentrate has been 292.7 HUF, therefore 39,7 HUF/kg average profit and 15.7% profitability could have been calculated in the processing industry.

In years between 2013 and 2015 (on average of the four facilities) production cost varied between 160.3-339.9 HUF/kg, and in the entire period the average production cost varied between 239.3 and 296.0 HUF/kg (Table 5). The difference in prime cost in different years can be traced back predominantly to industrial apple prices. The revenue of concentrate varied between 259.3 and 315.2 HUF/kg, therefore -24.7-99.0 HUF/kg net income and -7-62% profitability was experienced in the domestic processing industry.

Table 5: Production costs of domestic concentrate production between 2013 and 2015

Cost category	2013	2014	2015	Average
Basic data				
Quantity of processed industrial apple (th tons)	282.3	355.7	298.9	312.3
Produced concentrate (th tons)	41.3	52.0	43.7	45.7
Price of industrial apple (HUF/kg)	28.0	12.0	36.0	24.5
Base material cost (HUF/kg)	200.1	85.8	257.2	174.9
<i>raw material cost (HUF/kg)</i>	191.5	82.1	246.1	167.4
<i>bank cost (HUF/kg)</i>	8.6	3.7	11.1	7.5
Processing cost (HUF/kg)	77.7	74.5	82.7	78.1
<i>Variable costs of processing (HUF/kg)</i>	32.2	32.1	31.6	31.9
<i>gas</i>	17.4	17.3	17.2	17.3
<i>electricity</i>	4.6	4.6	4.6	4.6
<i>aid materials</i>	5.3	5.3	5.1	5.2
<i>other</i>	4.9	4.9	4.7	4.8
<i>Fix costs of processing (HUF/kg)</i>	45.5	42.5	51.1	46.1
<i>depreciation</i>	16.3	14.8	20.1	16.9
<i>wages</i>	27.2	25.6	28.6	27.0
<i>other</i>	2.0	2.0	2.4	2.2
Total production cost (HUF/kg)	277.8	160.3	339.9	253.0
Concentration revenue (HUF/kg)	311.0	259.3	315.2	292.7
Net income (HUF/kg)	33.3	99.0	-24.7	39.7
Contribution margin (HUF/kg)	78.8	41.4	26.5	85.9
Cost-related profitability (%)	12.0%	61.7%	-7.3%	15.7%

Source: own calculation

Note: Years represent the weighted average of the four facilities.

In case of the examined facilities (on average of the 3 years) production cost varied between 239.3 and 296.0 HUF/kg (Table 6). The difference between the prime cost of the facilities has been caused by the significant difference in processing cost above raw materials. The revenue of concentrate varied between 292.9 and 296.8 HUF/kg, therefore -4.1-53 HUF/kg profit and -1-22% profitability was experienced at individual facilities.

Table 6: Production costs of examined facilities between 2013 and 2015

Cost category	Facility A	Facility B	Facility C	Facility D
Price of industrial apple (HUF/kg)	24.1	26.5	24.3	24.4
Base material cost (HUF/kg)	174.5	187.6	173.7	172.4
Processing cost (HUF/kg)	121.5	111.3	65.6	110.5
<i>Variable costs of processing (HUF/kg)</i>	66.9	26.2	24.8	70.4
<i>Fix costs of processing (HUF/kg)</i>	54.6	85.1	40.8	40.1
Total production cost (HUF/kg)	296.0	298.9	239.3	283.0
Revenue (HUF/kg)	291.9	296.8	292.4	293.1
Net income (HUF/kg)	-4.1	-2.1	53.0	10.1
Contribution margin (HUF/kg)	50.5	82.9	93.9	50.2
Cost-related profitability (%)	-1%	-1%	22%	4%

Source: own calculation

Prime cost of apple juice concentrate are affected ceteris paribus by market, economic and environmental factors in the order and extent detailed below (these base parameters below give 100%: Prime cost 253 HUF/kg, output 6,84 kg/kg, working capital loan interest 9%, payback period is half a year, price of industrial apple 24.48 HUF/kg, 312 thousand ton processed industrial apple/year capacity utilization):

1. The fluctuation of the price of industrial apple (10-40 HUF/kg) causes change in prime cost in the interval of 58 and 140%.
2. Fluctuating capacity utilization between years (116 thousand - 482 thousand tons/year) can modify prime cost to 93-131%.
3. Depending on output (5.5-8.5 kg/kg) – which is a function of Brix of industrial apple and pressing efficiency – prime cost varies between 86-116%.
4. Payback period of working capital loan (6-12 months) may change prime cost in the interval of 100-103% while its interest rate (7-10.5%) may change prime cost in the interval of 99-101%.

Factors most significantly affecting profitability ceteris paribus modify revenue (Table 7) as detailed below (these base parameters give 100%: 39.7 HUF/kg profit, 24.48 HUF/kg industrial apple price, 312 thousand

tons processed industrial apple/year capacity utilization, 292.7 HUF/kg concentrate selling price):

1. The fluctuation of the price of apple juice concentrate (0.6-1.6 €/kg) causes change in prime cost in the interval of -160-620%.
2. The price of industrial apple (10-40 HUF/kg) may modify revenue in the range of -180-359%.
3. As a function of capacity utilization revenue varies between -96 and 139%.

Table 7: Attainable revenue with domestic apple juice concentrate production as a function of quantity of industrial apple produced, and the price of industrial apple and concentrate

Factors	Price of industrial apple (HUF/kg)	Concentrate selling price (HUF/kg)*					
		187.47 (0.6 €)	249.96 (0.8 €)	312.45 (1.0 €)	374.94 (1.2 €)	437.43 (1.4 €)	499.92 (1.6 €)
With 116 th tons of processed industrial apple (2011)	10	-39.7	22.8	85.3	147.8	210.3	272.8
	15	-75.4	-12.9	49.6	112.0	174.5	237.0
	20	-111.1	-48.7	13.8	76.3	138.8	201.3
	25	-146.9	-84.4	-21.9	40.6	103.1	165.6
	30	-182.6	-120.1	-57.6	4.9	67.4	129.8
	35	-218.3	-155.8	-93.4	-30.9	31.6	94.1
	40	-254.1	-191.6	-129.1	-66.6	-4.1	58.4
With 482 th tons of processed industrial apple (2012)	10	54.2	116.7	179.1	241.6	304.1	366.6
	15	18.4	80.9	143.4	205.9	268.4	330.9
	20	-17.3	45.2	107.7	170.2	232.7	295.2
	25	-53.0	9.5	72.0	134.5	196.9	259.4
	30	-88.7	-26.3	36.2	98.7	161.2	223.7
	35	-124.5	-62.0	0.5	63.0	125.5	188.0
	40	-160.2	-97.7	-35.2	27.3	89.8	152.2

*Calculated at 312.5 HUF/€ exchange rate

Source: own calculation

Based on my results there is significant correlation between apple production in the European Union and domestic industrial apple prices, prime cost of domestically produced concentrate and domestic export concentrate prices, domestic industrial apple price and domestic export concentrate prices.

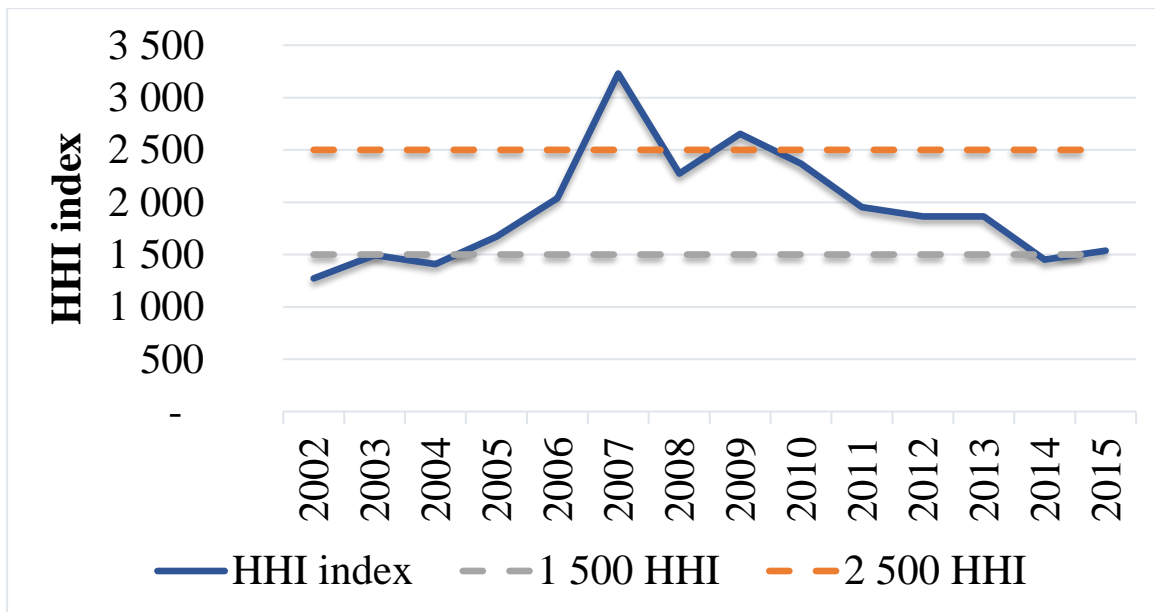
An explanation for the relatively low industrial apple price (that can be experienced on the domestic industrial apple market and poses a great

problem for producers) is that in case of average concentrate prices (0.94 €/kg) with average capacity utilization the net income will be zero at 30.2 HUF/kg industrial apple price. This means that this is the maximum price that the processor may pay for the producer on a long term to avoid losses. However, if the processor wants to achieve the average profit level of the sector, then no more than 24.6 HUF/kg will be paid for the raw material, and presumably this is the reason why the average industrial apple price is 24.48 HUF/kg. (Above 36.6 HUF/kg industrial apple prices that belong to the facility closure point, the processor purchases apple simply for the reason not to lose established customers, since strictly from an economic point of view he would be better off if the facility would not have started production in that year.) In the period between 2009 and 2015 only in 2015 was the price of industrial apple lower than the value belonging to the break-even point, but did not reach the facility closure point. The processing could have realized revenues above average profit in the sector in every second year.

The domestic apple juice concentrate production is a profitable activity (along with a fact that significant differences can be observed between individual facilities), and if raw material supply is going to be provided in the future and industrial apple prices do not persistently raise above 30.3 HUF/kg and the selling price of the concentrate will not drop below 0.81 €/kg, then the production of domestic apple juice concentrate will be profitable on a long term.

3. Does Hungary have a comparative advantage on the global market of apple juice concentrate?

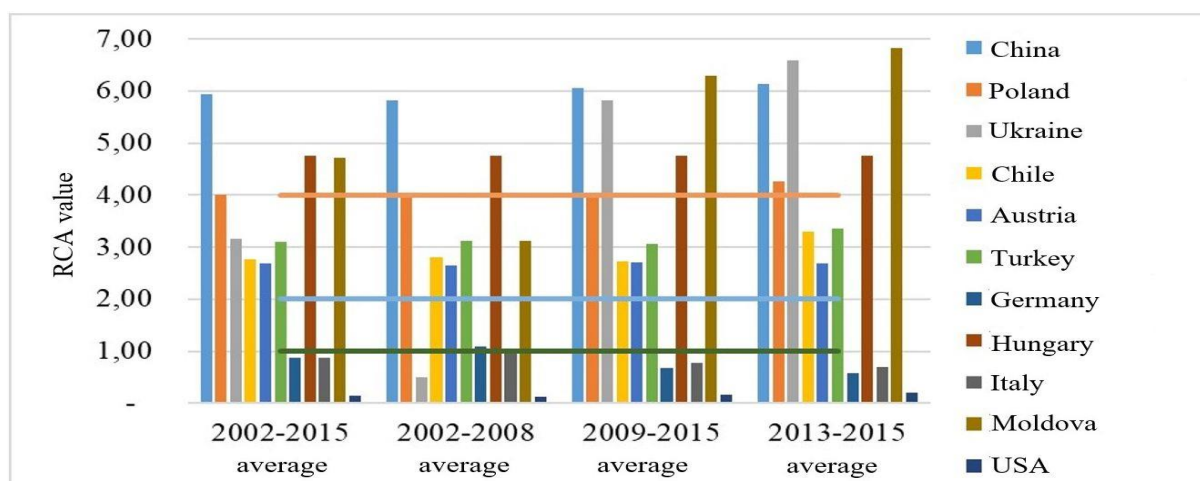
The market of apple juice concentrate is a concentrated market (Figure 3), since 40-60% of world market is possessed by China and Poland, and their leading position is guaranteed since the Millennium.



Source: Own calculation

Figure 3: Market concentration of apple juice concentrate (HHI) between 2002 and 2015

In the course of the last 10 years Hungary had a 2-3% market share of concentrate production and 2-5% market share from the volumes in international trade, therefore we can only act in a price following manner. The dominant players in the future will be the Polish due to their market share and dynamic growth. Domestic apple juice concentrate has strong comparative and commercial advantage on the world market (Figure 4). Based on the international trade competitive indicators, the competitive advantage of Hungary lags behind China.



Source: Own calculation

Figure 4: RCA index of countries with the largest market shares in the global market of apple juice concentrate

My opinion is that our market position is not threatened on the long run. The demand of concentrate is negatively affected by the decreasing consumption of fruit juices, but this might be compensated by the opening of the EU towards the USA and the partial decrease of Chinese concentrate on US markets. Therefore, stagnation or a slight growth can be expected on the EU concentrate market in the next 5-10 years. As a consequence, Chinese apple juice concentrate production and export will follow its decreasing trend that could have been experienced since 2011. Chinese apple juice concentrate will lose from its market dominance and will not exert major impact on the European market on a medium term.

4. How are costs and profit distributed in the industrial apple- apple juice concentrate product path segment?

In my studies the industrial apple - apple juice concentrate product path is covered by processors found in the Eastern part of the country, and 4000 ha specialized industrial apple plantations representing one quarter of the industrial apple orchards in Eastern Hungary, therefore producers and processors are of great significance in the region.

The cost on the examined product path is 5.618 billion HUF (64.6 HUF for 1 kg industrial apple), 57.2% of which is at the processing industry and 42.8% are worn by producers. The realizable profit on the product path is 1.338 billion HUF (16.0 HUF for 1 kg raw material), 63.6% of which is generated in production and 36.4% in processing.

In the specialized industrial plantations producers produce industrial apple on average at a prime cost of 27.6 HUF/kg, sell it for 24.48 HUF/kg, for which the producer receives 13.3 HUF/kg support, therefore realizes 10.2 HUF/kg income and 37% cost-related profitability (Table 8). Concentrate producers produce apple juice concentrate at a cost of 37.0 HUF/kg (for 1 kg industrial apple), and at a prime cost of 253.0 HUF/kg which is generally sold at a 292.7 HUF/kg concentrate price which results in 42.8 Ft revenue for 1 kg raw material. According to these data processors realize 5.8 HUF profit on 1 kg industrial apple which is 39.7 HUF per 1 kg concentrate.

Table 8: Comparison of the results of production and processing

Product path player	Indicator	Per 1 ha	Per 1 kg concentrate	Per 1 kg industrial apple
Producer	Cost (HUF)	600,684	189.07	27.65
	Revenue (HUF)	821,535	258.58	37.82
	Income (HUF)	220,851	69.51	10.17
	Profitability (%)	37%		
Processor	Cost (HUF)	803,768	252.99	37.00
	Revenue (HUF)	930,000	292.72	42.81
	Income (HUF)	126,232	39.73	5.81
	Profitability (%)	16%		

Source: Own calculation

There is a huge difference in cost-related profitability between production (37%) and processing (16%). However, profitability cannot directly compared in relation of these two players, this is not one dimension, since the economic characteristics of production and processing are very significantly differing from each other.

The distribution of raw material from specialized industrial plantation is: 29% comes from low production standard, 37% from moderate production standard and 34% from high production standard orchards. The distribution of the total 1.388 billion HUF profit of the product path is:38-34-27% among low-moderate-high production standard orchards respectively. The largest profit volume is generated in the low production standard product path segment (533 million HUF), and the moderate production standard product path segment generates the most cost (2.09 billion HUF). The lower the production standard, the less profit is generated in the production per one hectare due to the different yields that can be attained with the various standards of production. In case of low production standard, the 46% of total cost generated in the product path segment is generated at the producer and 54% at the processor, while profit is distributed in a 73%-27% proportion for the advantage of the producer. In the high production standard segment producer owns 40% of costs and 55% of profits, the processors have 60% of costs and 45% of profit. The average sectoral cost and profit distribution studied at domestic industrial apple-apple juice concentrate

product path is located between the low and moderate production standard.

A significant part of realizable revenues comes from supports. 82% of revenues generated in the product path segment belonging to the low standard production comes from AES and production coupled support, while this is 60% at moderate and only 40% at high standard production. Considering the entire product path, 63% of profit realized comes from these two kinds of support.

It must be noted that based on macroeconomic approach (ignoring supports) the profit generated on this product path is exclusively produced by the processor, since loss and negative profitability can be observed in production alone.

The majority of professional consultants say it is quite improbable that supports are going to be ceased after 2020, but according to the Chairman of the National Agro-economic Chamber (Nemzeti Agrárgazdasági Kamara) (2017)⁶ this level of support cannot be maintained. Along with decreasing level of supports, the only way to survive is to improve efficiency.

Under domestic conditions, industrial apple production is profitable at all of the three production standards if production coupled supports (93,235 HUF/ha) are received above SAPS (70,879 HUF/ha), and reception of AES support significantly improves profitability indicators. If the amount of support per 1 hectare will not reach the level of 140-150 thousand HUF, then only high production standard orchards will be established (only this kind of production will be economically viable), and if the level of supports remains below 70 thousand HUF/ha, then production will be ceased on low and moderate production standard plantations (they will produce loss even in short term).

Decrease of support levels could be compensated with increased yields and therefore increased revenues per hectare. The average yield could

⁶ Győrffy B. (2017): Agrárium 2020 után – A KAP reformja várható, szükség lesz a hatékonyság javítására. (Cap reform is expected, improvement in efficiency will be necessary) Agrárunió. 2017. évf. 1. sz. pp. 10-11.

be increased by protection against weather related events. This means plus inputs and investment that would result in yield sufficient for economical production. In case of high standard production, profitable production can be attained with the average yield (even without supports), but I think that regular irrigation would guarantee that increase in yield that would be sufficient to reach the level of rentability.

Another option to increase revenues is to increase selling prices, but these prices are determined by the market, producer cannot affect this factor. The trend function of industrial apple selling price $y=20.571 + 1.25x$ indicates an annual increase in selling prices by 1.25 HUF/kg. To reach the level of rentability, 40.34 HUF/kg at low production standard and 32.79 HUF/kg at moderate production standard, and 27.79 HUF at high production standard is required. Within the next 10 years, the increase in the selling price of industrial apple cannot compensate for the required level of supports.

If supports will be decreased after 2020, low and moderate standard plantations are prognosticated to be ceased, and only high standard specialized industrial plantations will survive.

Supports have only an indirect effect on processing, by providing the safety of raw material supply via the economic sustainability of plantations. If production will be ceased on low and moderate production standard plantations because they shall produce losses due to decreased levels of supports, processing industry will lose approximately 57 thousand tons of raw materials that is equal to 18% of the current average processing capacity. If this quantity is intended to be replaced by processing industry, 1,358 hectares of high production standard orchards should be established.

If this 57 thousand tons' volume is provided from industrial apple, 8,4 thousand tons less concentrate would be marketed which should mean 15-20% market loss and 333 million HUF loss of profits for the concentrate manufacturers. If processing industry will not be able to replace this lost raw material quantity, then prime cost would increase from 253 HUF/kg to 263.4 HUF/kg (due to decreased utilization in capacities), thus the income would decrease from 39.7 HUF/kg to 29.3 HUF/kg and profitability would fall from 15.7% to 11.1%.

Altogether, decrease in supports would have a detrimental effect on support-dependent raw material production with special regard to low

and moderate production standard orchards. Processing industry would be able to survive this temporary loss of raw materials originating from specialized industrial plantations becoming unprofitable, and on a long term processing industry would be able to replace these raw materials.

4 NEW AND NOVEL RESULTS OF THE DISSERTATION

- 1) I studied the 4000 hectares of specialized industrial plantations established to provide raw material for the apple juice concentrate production in Hungary based on different production standards. I determined the income generating capacity, efficiency for productive years and the rentability for the entire lifespan of the orchard of these plantation by paying special attention to the effect of supports. I concluded that due to current levels of supports, profitable and economical production can be conducted on Hungarian specialized industrial apple plantations, but without supports the production would result in losses and would become uneconomical.
- 2) I created a farm economic model appropriate for the economic analysis of apple juice concentrate production, in which results can be evaluated on corporate and on a sector level.
- 3) By conducting the representative cost-benefit analysis of Hungarian apple juice concentrate production I determined the income generating capacity of apple juice concentrate production and quantified the factors affecting profitability. On a long term the domestic apple juice concentrate production can be considered as a profitable activity on a sector level, with significant differences on corporate level in profitability.
- 4) I determined the significance and market position of Hungary on the global apple juice concentrate market with the help of international trade indicators based on secondary databases.
- 5) I determined the extent and distribution of the revenue generated on the entire product path and for its stages as well. I concluded that higher profitability can be attained in production than in processing, but the realizable revenue comes from supports.

5 THEORETICAL/PRACTICAL USABILITY OF RESULTS

My results provide guidance for sectoral development decisions for decision makers in sector policy with special respect to the fact that no economic analysis has been made on the profitability and rentability of domestic specialized industrial plantations and on the profitability of domestic apple juice concentrate production notwithstanding the overall analysis of the industrial apple-apple juice concentrate product path. Evaluation of the product path segment can contribute to the improvement of the efficiency of the sector, to the exploration of the sector's problems, introduces the jeopardies, hazards and market opportunities of the sector, therefore might ease, facilitate the work of project planners.

The results of the research can be valuable for the producer enterprises because these results are suitable for conducting an evaluation, analysis for any enterprise possessing a specialized industrial plantation but lacking an own accounting or farm economic system to determine efficiency, and may provide guidance for producers along their decisions in case of potential decrease in support levels. Additionally, the results of investment profitability calculations - including the impacts of various yield, quality and price factors and the critical parameters of rentability - may effectively facilitate producers and processors in preparing and concluding decisions of orchard establishment. These results provide a solid base for processing industry to determine their competitiveness among domestic conditions, and simulation of market and economic factors may provide help for processors to clarify the problems of the sector.

In the field of education these results contribute to the methodological developments pointing towards food industry of the farm economic analyses traditionally conducted by the Debrecen School of Farm Economics. My results will contribute and supplement the curriculum of "Horticultural economics" with the farm economic characteristics of the processing of horticultural products.

6 PUBLICATIONS IN THE SCOPE OF DISSERTATION



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List of publications related to the dissertation

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