University doctoral (PhD) dissertation abstract

SOME POSSIBILITIES FOR RISK ANALYSIS IN THE DECISION SUPPORT OF CROP PRODUCTION

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1. INTRODUCTION AND OBJECTIVE

Crop production usually consists of more enterprises among which there are differences in their products' market perception, production technology, resource-demand, time-scattering, in their time and need for field, agronomical interactions, the level of expenditures and profitability. The future status of external and internal factors, that affect the result of economic decisions, is not known by the farmer (*BÁCSKAI et al., 1976; HARDAKER et al., 1997; DRIMBA, 1998a),* and based on the contradiction that the decision concerning the business' future must be made at the time when reliable information are available about the previous period (*BUZÁS, 2000*). Risk presents in all areas of the economy and nobody can avoid it. In plant production beside economic risk the risk of weather's changeableness bears an increased significance. In extreme cases, catastrophe can evolve, however fluctuations from climatic conditions can induce positive and negative changes in the growth and development of crops and in their yields. These thoughts can suggest – and external observers often think so – that beside such level of uncertainty in the agriculture good weather, fertile ground, various assists and luck are needed for the good result. However, players in economic or business spheres must possess such means by which they can measure, oversee and manage the effects and consequences of risk. One condition of this is that for the decision-makers the information needed for decision should be available up-to-date, in appropriate quality and quantity and after their evaluation, process it allows setting up and analyzing various decision alternatives, variants. By this, the support of the most appropriate decision-making that matches to the style of decision-maker can be possible. This is the task of decision support. In the presence of needed information we can measure risk by using statistical means. Knowing the feature and level of risk, we can reject a possible alternative or if we decide so, by applying proper risk management tools we can even realize it. The thought about the risk's economic importance was born almost 90 years ago. Since then, almost in all areas of economic spheres also in agriculture significant results and applications have been evolved. The development of informatics and the internet gave a much bigger stamina to research; the practical utilization's availability is simpler and cheaper.

In this paper my general objective was to ensure efficient means for the crop production's decision support by applying present risk management methods, models and their development or by the adaptation of models which are used on other economic fields successfully taken into consideration their features of crop production.

My concrete objective can be separated into three main groups:

Presentation of the production risk for some field crops in the level of the European Union and the North Great Plain Region

The countries of the European Union have diverse climatic, natural and economic characteristics. These can be seen on the level and risk of agricultural production. By the greenhouse effect the production risk is rising and we can count with higher yield fluctuations. The European Committee gives high priority to the risks of agriculture. For the more efficient utilization of our negotiation power we must know – amongst other things – the main crops' calculated production risk in Hungary and in the other EU members, which demonstration and analysis is one of my objectives.

Considering Hungary's arable crop production, the North Great Plain Region has a significant role in it, because it occupies 21,5% of 4,5 million hectares, by which it is on the second place after the South Great Plain. If we see the fields' characteristics the state is more unfavorable. Within the region the difference among the quality of fields is significant. In the county of Szabolcs-Szatmár-Bereg the values of golden crown are the lowest, in the county of Hajdú-Bihar and Jász-Nagykun-Szolnok there are very good production sites. My aim is to present the main enterprises' production risk by field characteristics in the North Great Plain Region.

Considering risk during the creation of crop structure

In the crop sector conventional planning is the most common even nowadays, which means adequate planning, however determines increasing lag in the economic competition. In this agriculture with new challenges – environmental and nature conservation aspects, biomass energy, sustainable development, etc. – only those can take part in the competition who adapt to the environment. However, its condition is the execution of adaptive and optimizing planning together. One of my objectives is to present the importance of usage of linear programming and **risk programming models** by case studies and its advantages in the decision support of crop production. According to my plans during the application of risk programming models I am going to analyze the behavior to risk with and without assist.

Reducing marketing risk by using optimal wheat marketing strategies

The crop sector's special characteristic is that end-products appear at a biologically determined period, but their utilization is year-round. Selling prices are always the lowest at the harvesting period, after that they show a more or less identifiable seasonal fluctuation. This situation is further complicated by the fact that among the different crop years, we can notice great divergences in prices (*BÁCS, 2003; BÁCS – FENYVES, 2005*). Given the above, both on the side of producers and the biggest wheat-user enterprises – mill industry, animal husbandry – economic risk increases notably.

In my research I wanted to find the answer for the question that when and how much wheat have to be sold by the producer to choose financially the most favorable decision variant in the given financial-economic state. The problem is going to be solved by a **dynamic, simultaneous linear programming model** in which I am going to take into consideration the cash-flow balances by months, borrowing, alternative capital investment opportunities and stock-piling costs as well.

The abstract of databases, activities and outputs to be applied during the research can be seen in Figure 1.

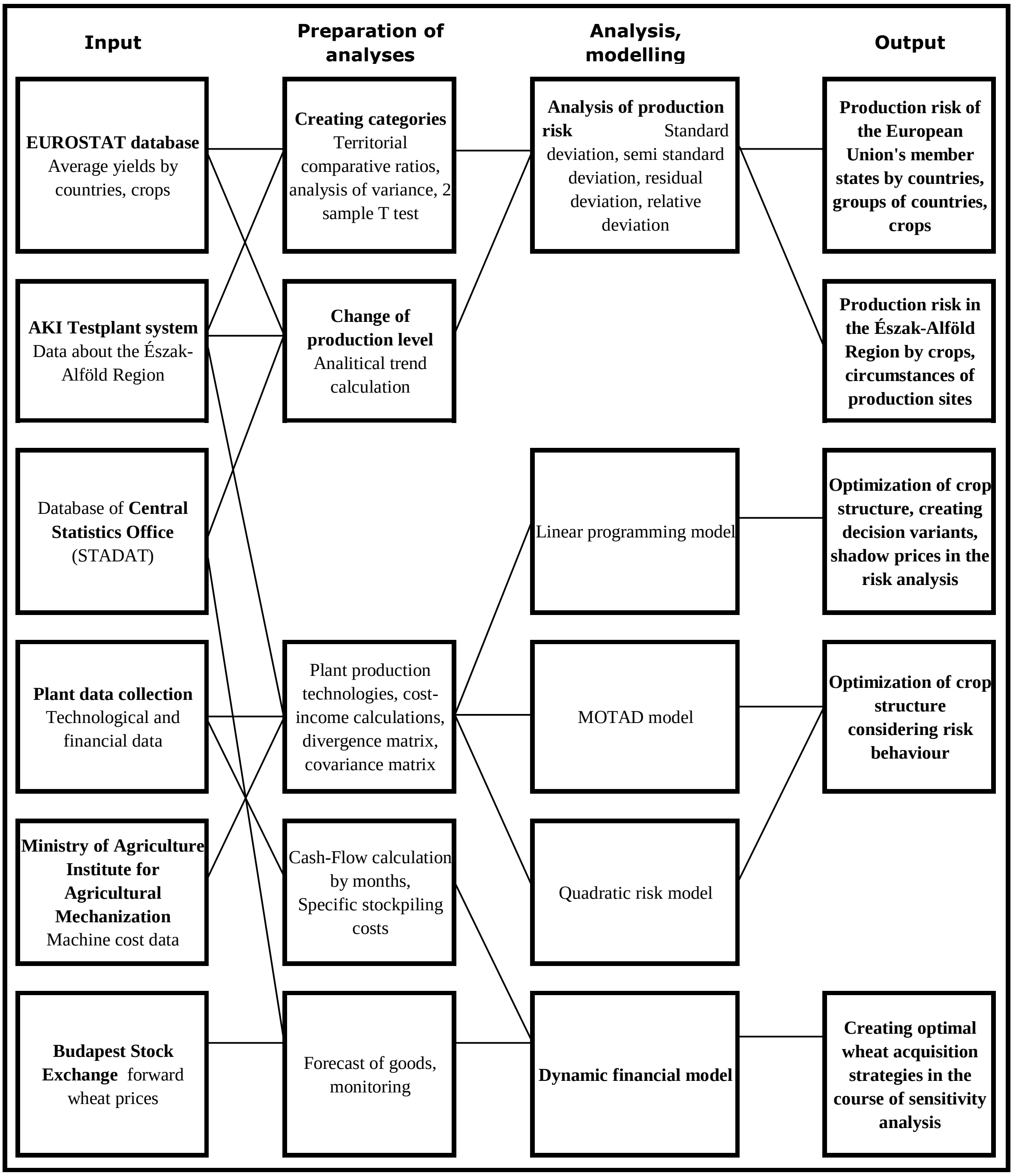


Figure 1. Objectives, inputs and activities of the research

Source: own assemblage

2. THE BACKGROUND OF THE RESEARCH AND THE APPLIED METHODS

2.1. The background of the research

The choice of my research project goes back to 2001; I started to deal with methods of decision support systems applied in crop plantation at this time. Afterwards, between 2004-2007, I actively took part in Nr. 46397 research project of Hungarian Scientific Research Fund, which subject was the „Methodological development of decision support and risk analysis of crop production”.

When defining the final scope of my doctoral and research thesis, I endeavoured to choose the topic in a way, which is in accordance both with the doctoral programme of Károly Ihrig Management and Organization Sciences Doctoral School and with the scientific work of the Department of Economic Analysis and Statistics.

2.2. The material of the research and the applied methods

Widespread data collection was needed in order to succeed in the objects defined in the introduction. I applied the EUROSTAT’s data between 1990- 2006 for calculation of the European Union countries’ production risk. In the course of the research I processed 15 countries’ yield data – Austria, Czech Republic, Denmark, France, Germany, Greece, Italy, Holland, Poland, Portugal, Slovakia, Spain, United Kingdom, and Hungary – and 7 crop production sectors – barley, potatoe, wheat, sugar beet, corn, sunflower, and rape. The Agricultural Economics Research Institute made the Test plant system’s data available for the production risk analysis in the North Great Plain Region between 2001-2005 and for the 8 crops: wheat, corn, barley, rye, sunflower, rape, sugar beet, peas.

The enterprise technologies’ basic data that are needed for the linear and risk programming models are from own data collection, I have been collecting information concerning crop enterprises from 15 agricultural undertakings since 2003. In the course of calculation of machine operational beside own data collection I used the comprehensive database of Ministry of Agriculture Institute for Agricultural Mechanization (GOCKLER, 2007a, b).

For the wheat’s price analysis I used the historical database of Budapest Stock Exchange between 1999-2006 and monthly buying-in data of Central Statistics Office between 2001-2007.

I typified the production risk by dispersions – standard deviation, relative deviation, semi deviation – and in the case of trend effect I calculated residual deviation, residual semi deviation. I checked the golden crown classifiability of field characteristics by statistical hypothesis testing, paired samples T-test and variance analysis.

I did the optimization of crop structure by using linear programming, I applied the MOTAD model and the quadratic portfolio optimizing model among the risk programming models that take into consideration the decision-makers' risk behavior.

In determining the optimal wheat selling strategy I compared the different statistical forecasting models' applicability and its accuracy by using follower mark in the course of wheat prices' forecast. For the creation of strategies DRIMBA-ERTSEY's (1999) financial planning model was the base and I made a new, dynamic simultaneous model which was needed to solve the problem.

For the statistical calculations I applied the SPSS 13.0 and XLSTAT 5.5 programs. The database operations that were needed for the creation of technologies were done by Microsoft Access 2003, the set-up, solving and formal post-work were made by Microsoft Excel 2003.

3. THE PRINCIPAL FINDINGS OF THE DISSERTATION

In the first part of my paper I analyzed some field crop enterprise's production cost on the level of European Union and the North Great Plain Region. In the next part I examined that what kind of possibilities we have to consider risk in the course of crop structure's planning and that how the different risk behavioral decision-makers react with and without assist. At last, I took up that when and how much to sell from the already produced goods to realize the highest income.

3.1. Analysis of production risk for some field crops in the level of the European Union and the North Great Plain Region

From the countries of the European Union, I made up classes according to their production level by applying area comparative ratios (Table 1).

Table 1. Evolution of average yields in the analyzed countries between 1990-2006 (Hungary =100%)

Country	Barley	Potato	Wheat	Sugar beet	Corn	Turnsole	Rape
Germany	162,3%	167,2%	174,0%	139,6%	148,3%	119,7%	180,9%
France	173,2%	173,0%	167,8%	184,8%	149,8%	121,2%	176,9%
United Kingdom	160,7%	184,6%	186,1%	133,0%	…	…	173,4%
Denmark	145,4%	173,0%	173,7%	136,4%	…	…	156,9%
Austria	131,2%	127,1%	123,6%	152,6%	163,8%	136,7%	146,3%
Czech Republic	115,9%	92,7%	114,9%	108,4%	101,9%	114,4%	146,0%
Slovakia	100,6%	66,9%	102,8%	98,0%	91,6%	100,8%	115,4%
Hungary	**100,0%**	**100,0%**	**100,0%**	**100,0%**	**100,0%**	**100,0%**	**100,0%**
Holland	169,9%	194,2%	202,1%	154,6%	194,1%	…	…
Spain	69,1%	114,0%	60,3%	146,7%	155,2%	50,4%	…
Italy	105,0%	105,7%	80,7%	119,2%	162,4%	117,0%	…
Greece	69,3%	103,5%	56,6%	156,1%	170,7%	68,8%	…
Poland	86,2%	79,9%	86,7%	96,9%	95,3%	…	…
Portugal	39,5%	64,9%	36,1%	…	86,6%	26,1%	…
Romania	74,1%	59,7%	63,1%	55,9%	58,1%	67,0%	…

Source: Own calculation by using EUROSTAT data

The Hungarian yield was the basis of comparison. In terms of countries allocated to the 1st group ("Western European Group") – Germany, France, United Kingdom, Denmark, Austria, Holland – the yield was at least 20% higher in each sector compared to the base. In terms of countries allocated to the 2nd group ("Hungarian Group") – Hungary, Czech Republic, Slovakia, Poland – with a few exceptions the range of values were fluctuated max. ±20% around the base. Spain, Italy and Greece formed the 3rd group ("Southern Group") where some of the plants had extremely high, while others had extremely low values compared to the base. Romania and Portugal can not be allocated to either group. Portugal has definitely lower yield, but similar rates as Spain, while Romania has the lowest production standard from the newcomer countries of the European Union.

For the 1st group, the more developed west-European countries – where the climate is characteristically constant oceanic and wet continental – high yields and lower risk is typical. *New member states* – 2nd group - lag behind not only in the level of production from the above-mentioned group, but *both in absolute and relative sense they produce with higher risk*. This can be explained with the more extreme climatic conditions and with the catching-up social, economic environment. While in the developed countries average yields have been rising in the latest 16 years, in the new member states, which joined in 2004, stagnation or decreasing tendency can be demonstrated. The 3rd group, from the point of risk Mediterranean countries constitute a separate group where in case of less intensively produced crops – for example cereals – production risk is extremely high, however in case of intensive, irrigated cultures higher yield can be reached with less risk. *Within the European Union Hungary is one of the most hazardous countries.* The values of *standard deviation* and *semi deviation* for *wheat* and sugar beet production are the highest. Rape is the only crop, which takes place in the middle.

Considering the agro potential North Great Plain Region is one of the weakest and the most heterogeneous area in Hungary. I examined the average golden crown value per one hectare, as a potential field characteristic impounding factor, for arable crops' average yields by using statistical hypothesis testing. It can be concluded that in case of some crops it was reasonable to separate the types of fields by this *grouping of golden crowns*, however there is no meaning to *grouping with more varied shades* from the point of the analysis. (Table 2.)

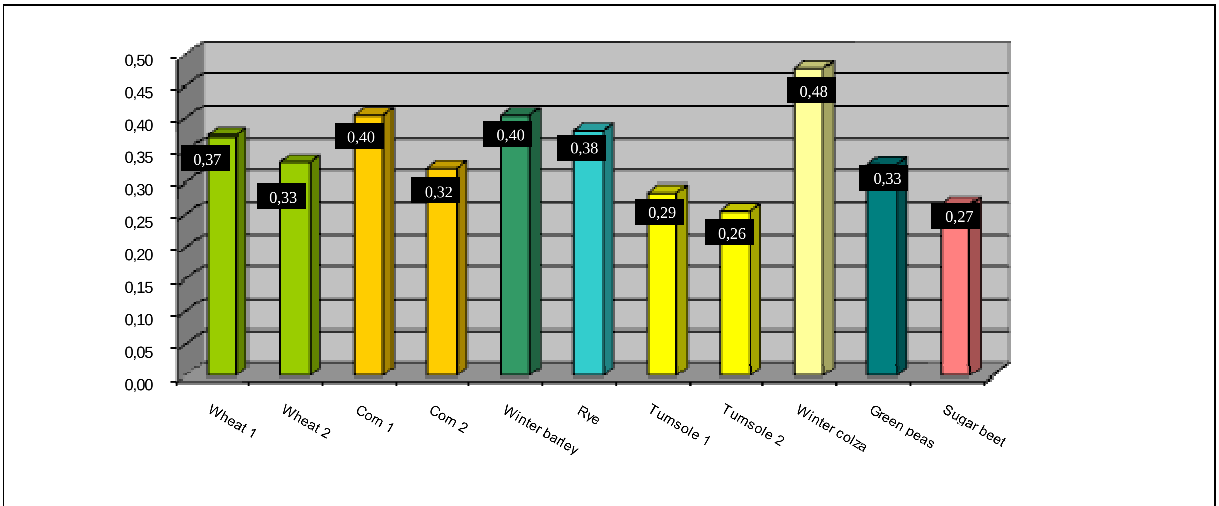
Table 2. Significant divergences among average yields by categories of golden crown*

Categories (golden crown/ha)	<13,31	13,31 - 16,46	16,47 - 19,62	19,63 - 22,78	22,79 - 25,93	25,93<
<13,31	-	KÁN	BKN	BKÁN	BKN	BKÁN
13,31 - 16,46	KÁN	-	BKÁN	BKNC	BKN	BKC
16,47 - 19,62	BKN	BKÁN	-			Á
19,63 - 22,78	BKÁN	BKNC		-		
22,79 - 25,93	BKN	BKN			-	
25,93<	BKÁN	BKC	Á			-

B=winter wheat; K=corn; Á=winter barley; N=turnsole; C= sugar beet
Among the categories of average yields the deviation is significan
at the indicated categories.

Source: own calculation

According to the values of relative residual deviation it can be demonstrated that *in the North Great Plain Region the riskiest is the production of winter colza and winter barley* and corn production's risk is also high on fields which quality is lower than the average. Irrespectively of field characteristic *turnsole* can be grown with *low risk* (Figure 2.).



*The 1st index behind the name of the plant indicates the risk of the below average- favoured areas, while the 2nd one indicates the risk of the above average- favoured areas

Figure 2. Evaluation of relative residual deviations in the analyzes enterprises

Source: own calculation

In the case of wheat, corn and turnsole I had the chance to compare below average and above average fields' production risk. It can be demonstrated for corn and turnsole that in worse years in those undertakings that possess above average fields the production risk is lower, while in better years the values of relative deviation are almost the same. In case of wheat the state is in reverse: the better production site's level-off effect to yield fluctuations is predominated in favorable years (Figure 3.).

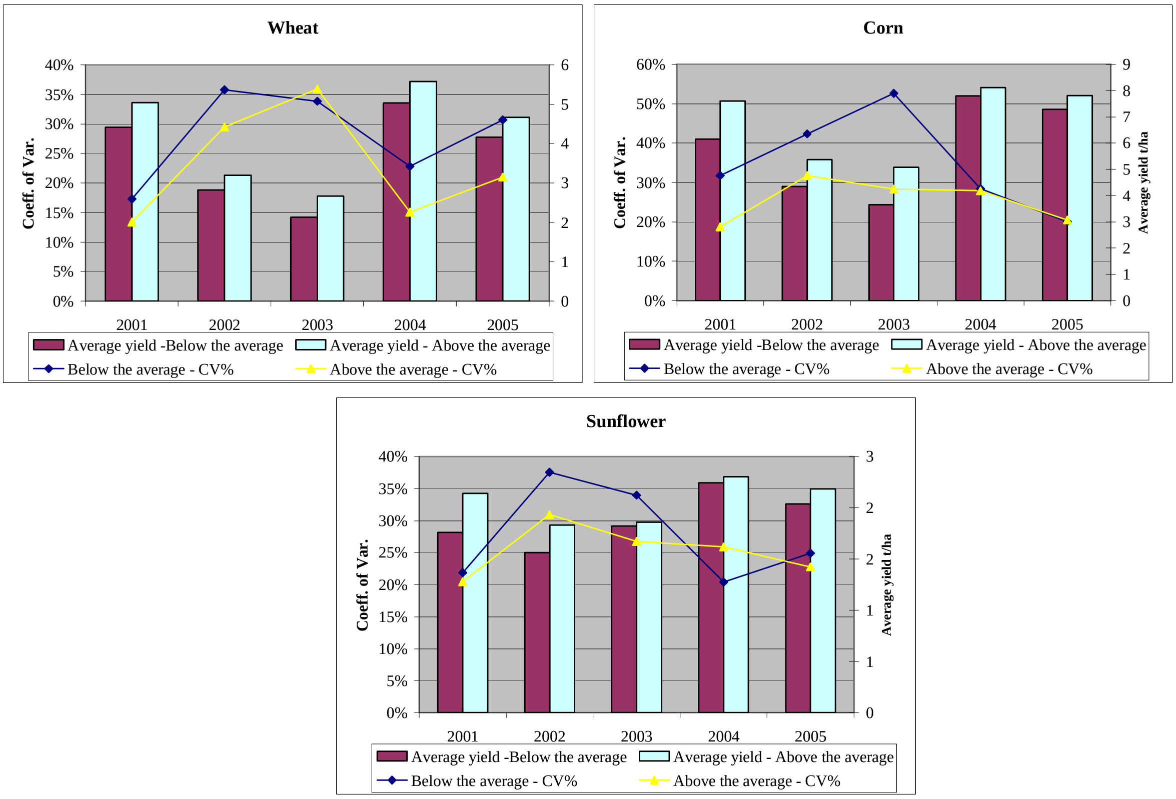


Figure 3. Wheat's, corn's and turnsole's average yields and production risk within 2001-2005

Source: own calculation

3.2. Optimizing crop structure by considering risk

Linear programming model makes for income maximalization and because of its deterministic character it is less suitable for considering risk. In the course of sensitivity analyses the proper interpretation of shadow prices can help us in the risk analysis as well. In my paper I am going to do the crop structure analysis of an undertaking of 2000 hectares.

In pursuance of the analysis of activities' shadow prices, we get a precise view of the enterprises' sensitivity to income changes. By the allowable increase and decrease an income interval can be determined within which, if its value is changed, the optimal crop structure remains unchanged. In practice it means that our production structure only have to be reasonably changed, i.e. rerun the model with new parameters, if the alteration exceeds the mower and upper limits. In other cases the **production structure shall not be changed, because we still realize the highest income with the available resources**. From the point of risk, the lower limit is more important for us, because it can acquit the undertaking of drastic income decrease (Figure 4.).

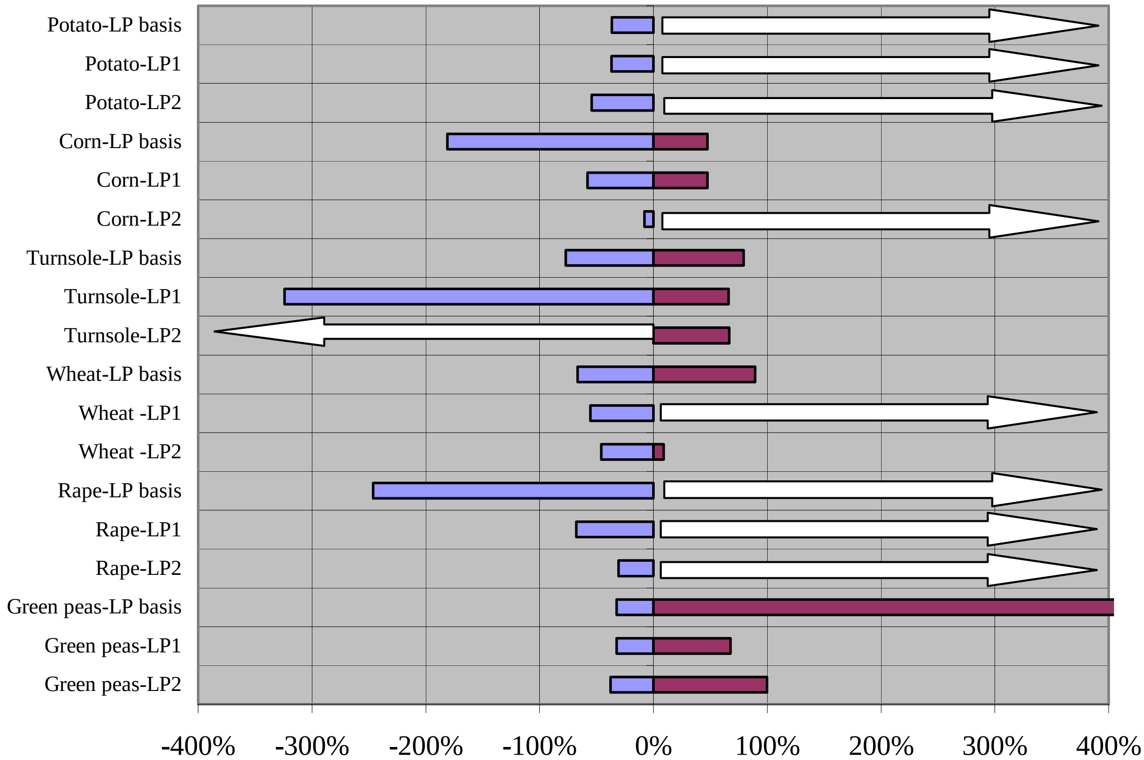


Figure 4. Sensitivity of the competed enterprises to profit contribution in various model variants *

*the arrows mean that in case of unrestricted growth or decrease of profit contribution the production structure does not change

Source: own calculation

We cannot ignore the fact that the highest risk is born by plan variants created by linear programming. Decision-makers do not always choose the plans with the highest income; their decision is affected by their behaviors to risk. The choice is created by using risk programming models.

In these models risk is typified by income fluctuation. In the MOTAD model we quantify by negative deviations from the average value and in the quadratic model by variance. In both cases – using the expected income as parameter – model serials and efficient curves are created and the most conforming plan to the individual's utility can be chosen by the relative change average.

In the case study I analyzed how efficient limit plans with and without assist set. It can be concluded that there are significant deviances in the production structure and risk if we use the MOTAD model, while in case of portfolio model we cannot see such a pronounced difference. The slope-change on the E-M efficient curve can be seen at higher opportunity cost with assist, and lower without assist, after that further opportunity cost goes with proportionality too slight risk decrease, and therefore further income decrease will not be accepted by even a strictly risk refusal decision-maker. This suggests that those decision-makers who are against risk may often choose plans with low expected value in the presence of assist, which worsens the competitiveness in a long-term. (Figure 5.).

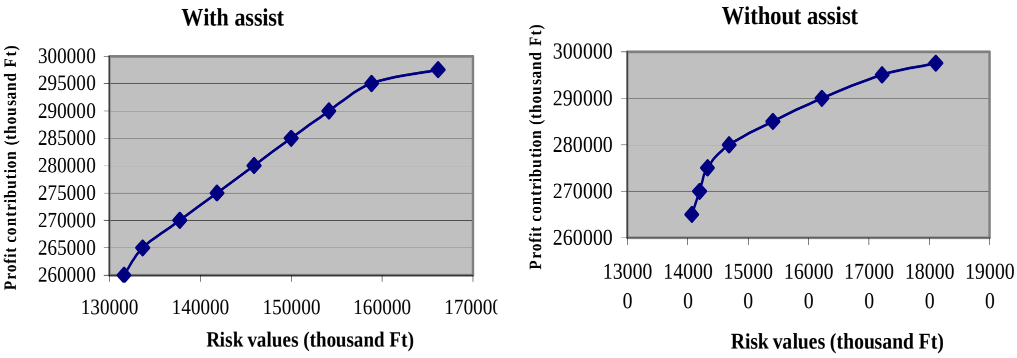


Figure 5. E-M efficient limiting curves

Source: own calculation

One condition of adaptive planning is the application of developed planning methods. Linear programming and risk programming models make possible more efficient decision-making. The implementation depends on the consistent operation of education, research and consultancy, in which the information technology instruments play an important role. In the expert systems thereby caused, risk management tools can play an important role.

3.3. Reducing marketing risk by using optimal wheat marketing strategies

The crop sector's special characteristic is that end-products appear at a biologically determined period, but their utilization is year-round. Selling prices are always the lowest at the harvesting period, after that they show a more or less identifiable seasonal fluctuation. This situation is further complicated by the fact that among the different crop years, we can notice great divergences in prices. Given the above, both on the side of producers and on the side of the biggest wheat-user enterprises, economic risk increases notably. For reducing costs forwards and futures and good-exchange options can be used, but in the countries of the European Union these techniques are not widespread. Either by futures, or contracts, or by free market ’sit-outs’, or by other methods is happening the sale, *not only the available selling price*, however this is beyond doubt the most important factor, *affects the marketing strategy to be chosen*. In the decision the financial state of the business, the available credit and its conditions, gains from alternative investment and stock-piling costs as well. My objective was to set up such a model by which we can examine these factors relatedly, at one time.

The creation of strategies is happened in three closely related steps. The first step is the forecast of prices, the second one is the setting up of the model, giving its parameters, solving and at last different decision variants are created by sensitivity analysis and after the comparative analysis is done, the decision can be made.

The first step, the reliable price forecast is a very important part of the exercise. There are a lot of available statistical methods and the most reliable must be chosen. For the comparison of methods and their continuous monitoring I used an easily applicable follower mark which was working at the forecast of needs. The gist of the follower mark’s use is that the error of the estimation shall be within a set-up interval, which can be narrower or wider according to the feature of the problem. If the value takes place out of the interval, the forecasting method must be re-examined, because it van happen that for the next period another method gives more reliable results. The advantage of the follower mark, beside its simplicity, is that in contrast to other techniques it requires constant freshening. I compared three techniques for the forecast of wheat prices: seasonal decomposition, moving average and Winter’s smoothing method, among which the third one proved to be the most reliable. (Figure 6.)

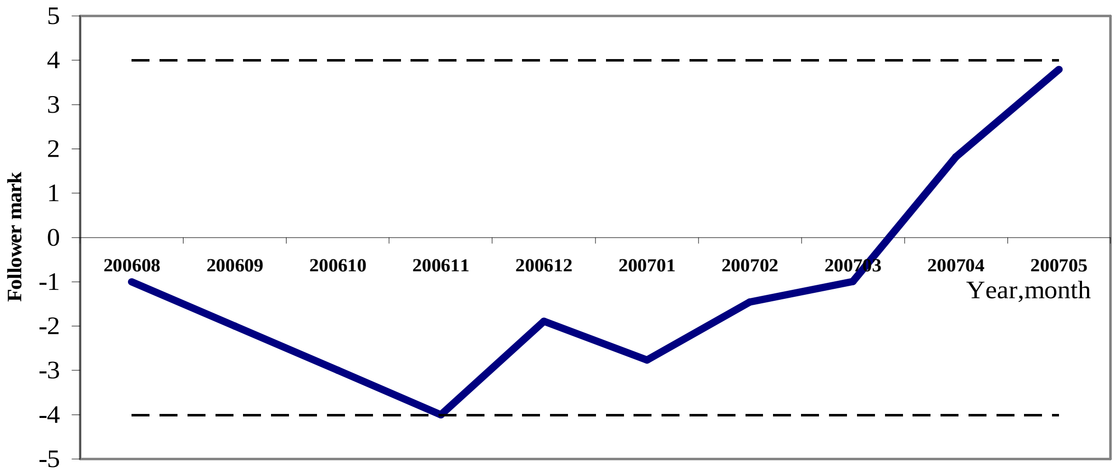


Figure 6. Evolution of the follower mark in the case of Winter's smoothing forecasting method

Source: own calculation

After the price forecast I set up such a *dynamic simultaneous financial model* to solve the problem that beyond the application of classical risk management methods manages stock-piling, equity-binding costs and it allows gaining maximal corporate income. (Figure 7.)

At the calculation of periodical money balances the paid out amount for the alternative investments is on the side of expenditures in the model, the planned Cash-Flow is on the side of liabilities; the borrowed money, the earnings of the wheat and the incomings from alternative investments mean turnovers. I store the closing balance by periods in a so-called transfer variable, which means of course that it is the opening balance for the next period. Credit constraint and the maximum amount that can be put into alternative investments can be fixed in the model. In the wheat's commodity balance I set the quantity of wheat to be marketed and we can set here if we allow stocks to be continued to the next period or not, by correctly using the relations. Constraints for alternative investments are model-technical. Besides, I modeled dynamically the change of wheat stock and I determined the average stock for all periods to calculate stock-piling costs.

Description	Alternative investments	1st period						...	1st period						R	Capacity vector
		Credit	Wheat marketing	Income of investments	Closing stock	Average stock	Transfer		Credit	Wheat marketing	Income of investments	Closing stock	Average stock	Transfer		
Money balance 1st period		-1					1	...							=	CF 1st period
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮		
Money balance 1st period							-1	...	-1					1	=	CF 1st period
Credit constraint		1						...	1						<=	H_{max}
Constraint for alternative investment	1							...							<=	A_{max}
Wheat commodity balance			1					...		1					=	V
jnth investment inth period	-1/h			1				...							=	0
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮		
Commodity balances jnth investment inth period	-1/h							...			1				=	0
Closing stock 1st period			-1		-1			...							=	-V
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮		
Closing stock 1st period					1			...		-1		-1			=	0
Average stock 1st period			1/2		1	-1		...							=	0
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮		
Average stock 1st period										1/2		1	-1		=	0
Objective function					0		0	...				0		0		MAX!

negative

psitive

Figure 7. The financial model's schematic structure

Source: own figure

After having solved the model, considering shadow prices I created more variants (Table 3.). A1 variant reflects the parameters given by the managers of the undertakings which mean that I did not calculate with credit or short-term investments.

Table 3. The set variants in the course of sensitivity analysis

Variant	Credit (thosand Ft)	Credit's interest rate	Constraint for investment (thousand Ft)
A1	0	12,0%	0
A2	20000	12,0%	0
A2_1	20000	7,50%	0
A3	20000	12,0%	50000
A3_1	20000	7,50%	50000

Source: own calculation

In Table 4. I summarized the results. It shows that, among the modeled variants by sensitivity analysis, A4 ensures with 7 percent higher income for the undertaking and in this case the whole quantity is sold in the buying-in period.

Table 4. The sensitivity analysis' summary data

Variant	Wheat marketing tons		Credit thousand Ft	Short-time investment thousand Ft	Objective function thosand Ft	Change of objective function (A1=100%)
	July	October				
A1	1 801,1	2 417,4	-	-	102783	100,0%
A2	1 801,1	2 417,4	-	-	102783	100,0%
A2_1	975,2	3 243,3	20 000	-	102912	100,1%
A3	3 865,6	352,9	-	50 000	106521	103,6%
A3_1	3 039,8	1 187,7	20 000	-	106650	103,8%
A4	4 218,5	-	20 000	100 000	109958	107,0%

Source: own calculation

Another advantage of the system-conceptual analysis is that price flexibility analysis becomes possible to execute. Lower and upper price limits in Table 5 mean that the result is going to alter if the objective function is risen above or reduced below. Blanks in the table mean that if the prices are moved up or down the result is unchanged in case of infinitely great alterations. In the case of A1, A2 and A3 variants' marginal prices are the same which means the three model's price flexibility is the same. In the course of A4 variant the upper marginal price is higher from September compared to other variants that refers to the advantage of short-term investments.

Table 5. The prices' extremes in the course of basic variants

Period	Objective function	A1		A2		A3		A4	
		Lower price bound	Upper price bound	Lower price bound	Upper price bound	Lower price bound	Upper price bound	Lower price bound	Upper price bound
July 2006	23,50	23,40	25,32	23,40	25,32	23,40	25,32	23,40	
August 2006	24,46		24,56		24,56		24,56	24,38	24,56
September 2006	26,63		27,32		27,32		27,32		27,40
October 2006	28,58	28,00	28,76	28,00	28,76	28,00	28,76		28,66
01 November 2006	29,61		30,20		30,20		30,20		30,28
01 December 2006	31,58		32,17		32,17		32,17		32,25
January 2007	32,47		32,91		32,91		32,91		32,95
February 2007	34,01	33,13	37,20	33,13	37,20	33,13	37,20	33,05	37,28
March 2007	34,87		37,06		37,06		37,06		37,06
April 2007	35,58		40,47		40,47		40,47		40,47
May 2007	35,80		44,24		44,24		44,24		44,24

Source: own calculation

The model that was set up can be used in practice, choosing and adapting the optimal marketing strategy improves the plant producing farms' competitiveness.

4. NEW AND NOVEL SCIENTIFIC RESULTS

- **On the area of production risk analysis**
  - *In the countries, which joined the European Union in 2004, the risk of plant production is higher both in absolute and relative sense,* compared to the developed west-European countries. *Hungary* is one of *the most hazardous countries* in the case of all plant production enterprises.
  - *In the North Great Plain Region the riskiest is the production of winter colza and winter barley* and corn production's risk is also high on fields which quality is lower than the average. Irrespectively of field characteristic *turnsole* can be grown with *low risk.* In the case of corn and turnsole, in worse years in those undertakings that possess above average fields the production risk is lower, while in better years there are no difference in the values of relative deviation.

- **On the area of crop structure optimization**
  - The adaptive and optimizing planning is an essential condition to increase the competitiveness of plant production. In the paper I presented that by the complementary usage of *linear programming and risk programming models the decisions of farmers can be made more established and according to their risk behavior they can choose from the possible plans.*

- **On the area of forming optimal wheat marketing strategies**
  - ***In the risk management of wheat marketing I set up a dynamic, simultaneous linear programming model,*** in which I took into consideration the cash-flow balances by months, borrowing, alternative capital investment opportunities and stock-piling costs as well. *By the adaptation of this model the marketing decisions can be made more well-grounded.*

5. PRACTICAL USE OF THE RESULTS

Plant production is one of the most hazardous agricultural enterprises, therefore considering and managing the risk is substantial in the course of planning.

My objective with this paper was to present the productions risk of field enterprises with scientific need and to attract the attention that by the adaption of conventional risk management methods – insurance contracts, forwards and futures, etc. the preparation for risk is not at an end.

- I found that *within the European Union Hungary is one of the most hazardous countries in the case of all plant production enterprises.* The values of *standard deviation* and *semi deviation* for *wheat* and sugar beet production are the highest. Rape is the only crop, in which we take place in the middle.

  I showed that which crops' production is the riskiest in the North Great Plain Region and that in the case of wheat, corn, and turnsole how the risk is evoluted in worse and better years. On the one hand, the practical knowledge of these motivates the framers to apply risk managing programs; on the other hand it helps to choose the crop in a more well-grounded way.

- The adaptive and optimizing planning is an essential condition to increase the competitiveness of plant production. In the paper I presented that by the complementary usage of *linear programming and risk programming models the decisions of farmers can be made more established and according to their risk behavior they can choose from the possible plans.*

- In the risk management of wheat marketing I set up a **dynamic, simultaneous linear programming model** that has not be applied yet**,** in which I took into consideration the cash-flow balances by months, borrowing, alternative capital investment opportunities and stock-piling costs as well. For the ease of practical adaptation of this model and for the check of the punctuality of forecasts, and for the proper forecasting method's application I used the follower mark. The model can be applied successfully for any arable crop to form an optimal marketing strategy.

6. PUBLICATIONS IN THE TOPIC OF THE DISSERTATION

Edition of scientific book/ course book in Hungarian:

1.	Szűcs I. – **Nagy L.** (2004): Gyakorlati alkalmazások. Az üzleti tervezés gyakorlata Campus Kiadó, Debrecen ISBN 963 86424 67	0,25

Scientific book/ section of course book in Hungarian:

2.	Ertsey I. – Molnár S. – **Nagy L.** (2005): Táblatörzskönyvek szerepe a növénytermesztés gazdasági elemzésében in: A mezőgazdaság tőkeszükséglete és hatékonysága szerk: Jávor A., Debrecen 122-128.p. ISBN 963 472 896 0	0,05
3.	Balogh P. – Kovács S. – **Nagy L.** (2008): A termelési és gazdálkodási kockázat vizsgálata sztochasztikus modellekkel in: Hatékonyság a mezőgazdaságban (Elmélet és gyakorlat) szerk.: Szűcs I. – Farkasné F. M., Agroinform Kiadó, Budapest 296-318 p. ISBN 978-963-502-889-4	0,05

Scientific journal in foreign language:

4.	**Nagy L.** – Gál T. (2007): Reducing the economic risk of animal husbandry by adapting acquisition strategies for optimal feed commodity. Scientifical Papers Animal Sciences and Biotechnologies, Timisoara p. 279-285. ISSN 1221-5287	0,2
5.	**Nagy L.** (2009): Some possibilities for risk analysis in the decision support of crop production. Apsctract (Applied Studies In Agribusiness And Commerce) Vol.3. No 1-2., Debrecen p.79-86. HU-ISSN 1789-221X	0,4

Hungarian scientific journal with summary in foreign language:

6.	Ertsey I. – **Nagy L.** – Balogh P. (2001): Az állatvédelmi törvények telepi-szintű alkalmazásának gazdasági hatásai a sertéstenyésztésben. Agrártudományi Közlemények 1. 76-80. p. HU-ISSN 1587-1282	0,067
7.	Bellon Z – **Nagy L**. – Ertsey Imre (2002): Informatikai alkalmazásokkal integrált növénytermesztési döntéstámogató rendszer. Szigma, 2002.XXXIII. évfolyam 3-4. szám 159-167.p. ISSN 0039-8128	0,067
8.	**Nagy L.** (2007): Mikor és mennyit vásároljunk? Optimális gabonavásárlási stratégiák. Agrártudományi közlemények, 2007/27, Debrecen 175-181. p. HU-ISSN 158731282	0,2

Presentation published in full in foreign language abroad:

9.	Balogh P. – Ertsey I. – **Nagy L.** (2000): Effect of the EU Animal Welfare Act on the profitability of pig production in Hungary. System methods of management and metrological maintenance of production. Materials of International Scientific Conference. Uzhgorod 28-30 november 2000., p. 185-192. ISBN 9-6310-5732-2	0,1

10. Balogh P. – Ertsey I. – **Nagy L.** – Kovács S.(2007): Examining the relative risk values of culling reasons in a large-skale pig farm, Sbornik Praci, Agrárni Perspektivy XVI., Evropské trendy v rozvoji zemedelství, Ceská Zemedelská Univerzita V Praze, Provozne Ekonomická Fakulta, Praha, p. 1053-1059. ISBN 978-80-213-1675-1 — 0,075

11. Balogh P. – Ertsey I. – **Nagy L.** – Kovács S.(2007): Risk analysis of a large-scale pig farm investment plan, Proceedings of the third scientific conference on Rural Development, Lithuania p.254-261. ISSN 1822-3230 — 0,075

12. **Nagy L.** – Gál T. (2007): Reducing market risk by adapting optimal cereal-acqusition strategies. Proceedings of the third scientific conference on Rural Development, Lithuania p.240-246. ISSN 1822-3230 — 0,15

13. Balogh P. – Ertsey I. – **Nagy L.** – Fenyves V. (2008): Analysis and optimization of the structure of Hungarian pork integration as a general network flow. 8^{th} International Conference on Management in AgriFood Chains and Networks. Abstrakt: p.18. and a pendrive enclosure. Netherlads, Wageningen. — 0,075

14. Fenyves V. – Ertsey I. – **Nagy L.** – Nagy A. (2008): Seasonal tendencies in international lamb trade Agrarian Perspectives XVII. „European Trends in the Development of Agriculture and Rural Areas" International Scientific Conference Volume II, Prague, Czech Republic, p. 671-675. ISBN 978-80-213-1813-7 — 0,075

15. Balogh P. – Ertsey I. – Fenyves V. – **Nagy L.** (2008): The stucture of pork integration's analysis and optimization in Hungary as a general network flow Agrarian Perspectives XVII. „European Trends in the Development of Agriculture and Rural Areas" International Scientific Conference Volume II, Prague, Czech Republic, p. 663-667 ISBN 978-80-213-1813-7 — 0,075

16. Kovács S. – Csipkés M. – **Nagy L**. – Ertsey I.: Risk Analysis and Efficiency of Milling Industrial Investments in Hungary. IV. World Congress of Agronomists and Professionals in Agronomy. 28-30 October 2008. Madrid, p.69. — 0,075

Presentation published in Hungarian with summary in foreign language:

17. **Nagy L.** (2007): A növénytermesztés termelési kockázatának elemzése különböző termőhelyi adottságoknál az Észak – Alföldi régióban; Agrárgazdaság, Vidékfejlesztés, Agrárinformatika Nemzetközi Konferencia, Debrecen, Cd melléklet, ISBN: 978-963-87118-7-8 — 0,1

18. Csipkés M. – Ertsey I. – **Nagy L**. (2008): Vetésszerkezeti variánsok összehasonlító elemzése a Hajdúságban. XI. Nemzetközi Tudományos Napok, Gyöngyös 14-21 p. ISBN 978-963-87831-1-0 — 0,033

19. **Nagy L.** (2008): Néhány növénytermesztési ágazat termelési kockázatának alakulása az Európai Unióban. XI. Nemzetközi Tudományos Napok, Gyöngyös 72-79 p. ISBN 978-963-87831-1-0 — 0,1

20.	Balogh P. – **Nagy L.** – Fenyves V. (2008): Hálózat optimalizálás szervezése egy sertéshús integrációban "Hagyományok és új kihívások a menedzsmentben" nemzetközi konferencia 2008. október 2-3. 106-113. p. Debrecen ISBN: 978-963-9822-08-5	0,033
21.	Ertsey I. – Kovács S. – Csipkés M. – **Nagy L.** (2008): Malomipari beruházások kockázat- és gazdaságossági vizsgálata Magyarországon "Hagyományok és új kihívások a menedzsmentben" nemzetközi konferencia 2008. október 2-3. Debrecen 199-205. p. ISBN: 978-963-9822-08-5	0,025
22.	Kovács S. – **Nagy L.** (2008): Szimulációs modellek alkalmazása a növénytermesztés vetésszerkezetének optimalizálásában. I. Országos Gazdasági és Pénzügyi Matematikai PhD Konferencia 2008. október 20., Budapest 33-39.p. ISBN 978-963-9263-41-3	0,05
23.	Csipkés M. – **Nagy L.** (2008): Az értékesítési kockázat csökkentése optimális búzaértékesítési stratégiák segítségével. I. Országos Gazdasági és Pénzügyi Matematikai PhD Konferencia 2008. október 20., Budapest 41-48.p. ISBN 978-963-9263-41-3	0,05

Presentation published in full in foreign language in Hungary:

24.	Grasseli G. – **Nagy L.** – Csipkés M. – Gál T. – Szendrei J. (2009): Economic calculations of the material and energy flows in the biogas process. Internal Congress on the aspects and visions of applied economics and informatics (AVA4), Debrecen p. 1310-1316. pendrive enclosure ISBN 978-963-502-897	0,03
25.	Szőke Sz. – **Nagy L**. – Kovács S. – Balogh P. (2009): Examination of pig farm technology by computer simulation. Internal Congress on the aspects and visions of applied economics and informatics (AVA4), Debrecen p. 1317-1325. pendrive enclosure ISBN 978-963-502-897	0,038
26.	Kovács S. – **Nagy L.** (2009): An application of Marcov chain Monte Carlo simulation. Internal Congress on the aspects and visions of applied economics and informatics (AVA4), Debrecen p. 1333-1338. pendrive enclosure ISBN 978-963-502-897	0,075
27.	Balogh P. – Fenyves V. – **Nagy L.** (2009): Is integration the way to the future of the pig sector? Internal Congress on the aspects and visions of applied economics and informatics (AVA4), Debrecen p. 1326-1332. pendrive enclosure ISBN 978-963-502-897	0,05
28.	**Nagy L** (2009): Reducing sales risk by adapting optimal wheat selling strategies. Internal Congress on the aspects and visions of applied economics and informatics (AVA4), Debrecen p. 1376-1381. pendrive enclosure ISBN 978-963-502-897	0,15
	Cumulated Publication Value (CPV)):	2,718

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