Acta oeconomica et informatica 2
Nitra, Slovaca Universitas Agriculturae Nitriae, 2008, s. 29–34

USING OPTIMALISATION MODELLING IN MARKETING MANAGEMENT OF EFFICIENT PRODUCTION OF PORK

VYUŽITIE OPTIMALIZAČNÉHO MODELOVANIA V MARKETINGOVOM MANAŽMENTE EFEKTÍVNEJ VÝROBY BRAVČOVÉHO MÄSA

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The situation in pig breeding in Slovak Republic has been unfavourable in the long run. Numbers of sows and fattening pigs have been decreasing incessantly, number of producers is being reduced, imports of pigs and pork from other EU countries are on the rise. This is the consequence of the deepening unprofitability of pig breeding. Opportunities for correction and further positive development are presented in this paper. Using optimalisation model it quantifies the impact of cost changes, realisation prices, production and reproduction indices, on economic results of pig breeding. Based on this, it determines the level of relevant production and economic parameters so as to make pig breeding profitable.

Key words: optimalisation model, pig breeding, production indices, costs, prices

The unfavourable situation in pig breeding in Slovakia is intensifying incessantly. Numbers of sows continue to decrease (from 131 thousand in 2000 to 67 thousand in 2007), those of fattening pigs as well (from 742 thousand to 420 thousand for the same period). At the same time, two differing trends are getting manifested: growing number of farms with low pig concentration (up to 50 sows) and, on the other hand, increased mean concentration of animals in larger farms (above 500 sows). Also increasing is the import, not only of pork but also of carcass pigs and weanlings to be fattened, from other EU countries to Slovakia. Reproduction and efficiency parameters are getting consolidated though, but are still lagging behind the developed countries. Their level is determined by a whole complex of factors of zootechnical-breeding, technical--technological, nutrition and biological character (Bulla, 2005; Brestenský et al. 2002; Mihina et al., 1999). An important factor of pig breeding efficiency is the price level of carcass pigs. A detailed analysis of pork prices development was made by Kretter (2003) who points out considerable seasonal price fluctuation in the course of year, emphasising more dynamic price changes in pork as compared with those in beef. Grimek (2005) characterises the present situation in meat market as commercial pressure for price reduction. The unfavourable price development is better controlled by big producers, but even here the yields were reduced by 3 to 10 %. Severalauthors apply the quantitative methods at prognostics and market structure modeling (Stehlíková, 2004; Rost and Čermáková, 2003). Solving the problems in pig breeding via models was undertaken by Farkašová (2000) who, using polynomic functions, investigated correlations between costs proper and efficiency in pig breeding.

The paper intends to quantify, using optimalisation model, the expected impact of changes, costs, realisation prices of carcass pigs, production and reproduction pig indices to economic results of pig breeding so as to enable farm managers using information from this model in a complex of marketing instruments secure favourable economic results of pig breeding.

Material and methods

Data necessary to solve the given problems have been obtained from Situation and Prospective Reports of Ministry of Soil Culture, Slovak Republic, for the years 2001 to 2006, proper costs and management results of agricultural corporations in SR for 2001 to 2005, issued by Research Institute of Economics in Agriculture, Bratislava, and monthly reports on animal production and animal products sale Poľ (Agr) 1–12 for 2000 to 2006. The obtained numeric factography has been classified, processed and evaluated using optimalisation model. The aim of the model is to consider the economy of pig breeding from the aspect of real financial flows respecting at the same time production, reproduction and economic relations between respective pig categories. Based on calculated values, the model predicted cost changes and realisation prices of carcass pigs, production and reproduction indices to pig breeding economy.

General figure of optimalisation model:

Final function (*FUF*):

$$FUF: Z_{max(min)} = \sum_{j=1}^{n} c_j x_j \quad (1)$$

Proper restricting conditions (*RCOP*):

$$RCOP: \sum_{j=1}^{n} a_{ij} x_j \leq; =; \geq b_i \quad (i = 1, 2, ..., m) \quad (2)$$

Condition of non-negativity (*PN*):

$$PN: x_j \geq 0 \quad (3)$$

where:

cj – coefficient of final function (price coefficient) expressing 1 unit of *j*-th variable,

xj – sought value (magnitude) of *j*-th variable,

aij – technical-economical coefficient of *i*-th range related to the unit of *j*-th variable,
bi – right margins of proper restricting conditions,
n – number of variables,
m – number of restricting conditions,
Values *cj, aij, bi* are constant.

Used for model solution of pig breeding in Slovakia was software HAPPY – Home Agricultural Production Planning sYstem created specially for the needs of biological--mathematical analyses and prognosing of all branches of agricultural production both on enterprise level and on the level of the branch as a whole.

Reversal point was determined for particular indices, making it possible to set the margin of economical efficiency for each index, i.e. index level to achieve profit.

Reversal (critical) point can be determined from relation:

$$P \cdot c = v \cdot P + F$$

where:
P – production volume,
c – market price for production unit,
v – variable cost for production unit,
F – total fixed cost.

Profit and/or loss for accounting year per hundred sows of basic herd and other turnover categories created based on real production and reproduction indices have been calculated as a difference of total yields and total costs: the former including earnings from sow culling, from sales of fattening pigs meat, activation of basic herd sows.

Model solution is applied in two variants with model representation of 100 sows of the basic herd and subsequent turnover categories of sows. The first variant of calculation has been done based on real mean production, reproduction, cost and price indices in pig breeding in Slovak Republic for the year 2005 (cost per 2006 have not been available yet) as stated in Table 1.

The second variant calculated the economic point of reverse in pork production when cost per 100 sows breeding, including corresponding scope of other pig categories, equal the sales for produced fattening pigs. Based on this, the second variant changes production and reproduction indices while respecting EU valid prices. To achieve the economic reversal point in pork production, beeders must achieve parameters given in the second column of Table 1 as compared with present reality.

Table 1 Production, reproduction and economic indices: input to optimalisation model

Index (1)	Variant 1	Variant 2
Number of sows in pcs (2)	100.00	100.00
Culling of sows in % (3)	42.00	42.00
Sucklings born per 1 sow in pcs (4)	18.75	23.63
Suckling mortality rate in % (5)	9.00	9.00
Weight of animals at the start of fattening in kg.pc^{-1} (6)	8.50	8.50
Mortality rate during time total of fattening in % (7)	4.00	4.00
Mean weight of fattening pigs at sale in kg.pc^{-1} (8)	107.00	107.00
Mean weight of culled sows at sale in kg.pc^{-1} (9)	184.05	184.05
Net cost per 1 fattening day in sow category in Sk.KD^{-1} (10)	60.88	60.88
Net cost per 1 fattening day in pig fattening category in Sk.KD^{-1} (11)	21.49	21.49
Realisation price of culled sows in Sk.kg^{-1} (12)	25.00	25.00
Realisation price of fattening pigs in Sk.kg^{-1} (13)	39.00	39.00

Tabuľka 1 Produkčné, reprodukčné a ekonomické ukazovatele vstupujúce do optimalizačného modelu
(1) ukazovateľ, (2) počet prasníc v ks, (3) brakovanie prasníc v %, (4) narodenie ciciakov na 1 prasnicu v ks, (5) úhyn ciciakov v %, (6) hmotnosť zvierat pri zaradení do výkrmu v kg.ks^{-1}, (7) úhyn počas celej doby výkrmu v %, (8) priemerná hmotnosť výkrmových ošípaných pri predaji v kg.ks^{-1}, (9) priemerná hmotnosť brakovaných prasníc pri predaji v kg.ks^{-1}, (10) vlastné náklady na 1 kŕmny deň v kategórii prasnice v Sk.KD^{-1}, (11) vlastné náklady na 1 kŕmny deň v kategórii výkrm ošípaných v Sk.KD^{-1}, (12) realizačná cena brakovaných prasníc v Sk.kg^{-1}, (13) realizačná cena výkrmových ošípaných v Sk.kg^{-1}

Results and discussion

Resuls of model solution calculations in accordance with the above variants are shown in the following tables (2, 3, 4).

The second variant is explicitly characterised by more favourable parameters. Its use shall secure a greater number of fatttening pigs sold and a shorter period of fattening, i.e. a higher turnover of fattening and more efficient use of stable room.

Based on herd turnover data, economic evaluation of the two variants has been performed. Profit and/or loss have been calculated as a difference of sales and total costs per 100 sows respecting the principles of herd turnover, i.e. total costs including profits from sow culling and from fattening pigs sales, whereas total costs per 100 sows included the corresponding condition of other categories of pigs up to their out-storage in slaughter weight of 107 kg.

Calculated economic parameters per individual pig categories point at more positive economic results in the second variant. Cost per basic herd sow breeding are the same, cost per suckling breeding is lower by up to 21 %, and

Table 2 Herd turnover in natural indices

Index (1)	Variant 1	Variant 2	Index V2/V1
Number of sows (2)	100.00 pcs	100.00 pcs	1.00
Sows culled (3)	42.00 pcs	42.00 pcs	1.00
Suckling mortality rate (4)	168.75 pcs	212.67 pcs	1.26
Suckling rate needed for sow breeding (5)	42.00 pcs	42.00 pcs	
Suckling transfer to fattening (6)	1706.25 pcs	2 150.33pcs	1.26
Pig mortality rate in fattening (7)	67.00 pcs	84.00 pcs	1.25
Fattening pig sales (8)	1598.18 pcs	2 024.00 pcs	1.26
Mean annual capacity in fattening (9)	755.89 pcs	814.66 pcs	1.07
Fattening period of 1 pc in days (10)	172,63.days	146.87 days	0.85

Tabuľka 2 Obrat stáda v naturálnych ukazovateľoch
(1) ukazovateľ, (2) počet prasníc, (3) brakovanie prasníc, (4) úhyn ciciakov, (5) potreba ciciakov pre odchov prasničiek, (6) prevod ciciakov do výkrmu, (7) úhyn ošípaných vo výkrme, (8) predaj výkrmových ošípaných, (9) priemerný ročný stav vo výkrme, (10) d oba výkrmu 1 kusa v dňoch

Table 3 Calculated indices per sow category

Serial no. (1)	Index (2)	Unit of measur. (3)	Variant 1	Variant 2
1.	Mean number of sows (4)	pcs	100.00	100.00
2.	Cost per 1 mean pc per year (5)	Sk	22,221.83	22,221.83
3.	Cost per 1 fattening day (6)	Sk	60.88	60.88
4.	Culling of basic herd sows (BH) (7)	%	42.00	42.00
5.	Mean weight of culled sow (8)	kg	184.05	184.05
6.	Number of pcs (9)	pcs	42.00	42.00
7.	Toal weight of culled sows (10)	ton	7.73	7.73
8.	Market price of 1 kg meat of culled sows (11)	Sk	25.00	25.00
9.	Sales for culled sow meat (12)	Sk	193,252.00	193,252.00
10.	Cost per BH of sows (13)	Sk	2,222,103.00	2,222,103.00

Tabuľka 3 Vypočítané ukazovatele za kategóriu prasnice
(1) poradové číslo, (2) ukazovateľ, (3) merná jednotka, (4) priemerný počet prasníc, (5) náklad na 1 priemerný kus za rok, (6) náklad na 1 kŕmny deň, (7) brakovanie prasníc základného stáda (ZS), (8) priemerná hmotnosť brakovanej prasnice, (9) počet kusov, (10) hmotnosť brakovaných prasníc spolu, (11) trhová cena 1 kg mäsa brakovaných prasníc, (12) tržba za brakované mäso prasníc, (13) náklady na ZS prasníc

Table 4 Calculated indices per suckling category

Serial no. (1)	Index (2)	Unit of measur. (3)	Variant 1	Variant 2	Index V2/V1
1.	Number of sucklings born per sow (4)	pcs	18.75	23.63	1.26
2.	Total number of sucklings born (5)	pcs	1,875.00	2,363.00	1.26
3.	Suckling mortality rate (6)	%	9.00	9.00	1.00
4.	Breeding per 1 mean sow of BH (7)	pcs	17.06	21.50	1.26
5.	Mortality rate of sucklings per 1 sow of BH (8)	pcs	1.69	2.13	1.26
6.	Transfer to fattening (9)	pcs	1,706.25	2,150.33	1.26
7.	Weight at transfer to fattening (10)	kg	8.50	8.50	1.00
8.	Price cost of 1 suckling at tansfer (11)	Sk	1,228.66	971.84	0.79
9.	Price cost per 1 kg at transfer (12)	Sk	144.55	114.33	0.79

Tabuľka 4 Vypočítané ukazovatele za kategóriu ciciaky
(1) poradové číslo, (2) ukazovateľ, (3) merná jednotka, (4) počet narodených ciciakov na prasnicu, (5) počet narodených ciciakov, (6) úhyn ciciakov, (7) odchov na 1 priemernú prasnicu ZS, (8) počet uhynutých ciciakov na 1 prasnicu ZS, (9) prevod do výkrmu, (10) hmotnosť pri zaradení do výkrmu, (11) nákladová hodnota 1 ciciaka pri prevode, (12) nákladová hodnota 1 kg pri prevode

Table 5 Calculated indices per pig fattening category

Serial no. (1)	Index (2)	Unit of measur. (3)	Variant 1	Variant 2	Index V2/V1
1.	Mean annual numbers (4)	pcs	755.89	814.66	1.07
2.	Mean daily increment (5)	kg	0.57	0.67	1.17
3.	Out-storage weight (6)	kg	107.00	107.00	1.00
4.	Breeding period of 1 pc in category (7)	day	164.08	150.32	0.92
5.	Weight increase of 1 pc in category (8)	kg	98.40	98.40	1.00
6.	Sale in pcs (9)	pcs	1,598.18	2,024.63	1.26
7.	Market production – out-storage (10)	ton	171.01	216.64	1.26
8.	Cost per 1 fattening day (11)	Sk	21.49	21.49	1.00
9.	Cost per 1 kg increment (12)	Sk	37.70	32.07	0.85
10.	Cost per breeding 1 pc in category (13)	Sk	3,709.84	3,156.14	0.85
11.	Calculated cost per mortality of 1 out- stored pc (14)	Sk	12.88	10.17	0.78
12.	Total cost value at sale (15)	Sk	4,994.28	4,173.01	0.83
13.	Total cost value of 1 kg live weight (16)	Sk	46.68	39.00	0.83
14.	Market price per 1 kg live weight (17)	Sk	39.00	39.00	1.00
15.	Market price of 1 pc (18)	Sk	4,173.00	4,173.00	1.00
16.	Profit or loss in 1 pc sale (19)	Sk	-821.28	0	–
17.	Profit or loss per breed total (20)	Sk	-1,312,545.25	0	–

Tabuľka 5 Vypočítané ukazovatele za kategóriu výkrm ošípaných
(1) poradové číslo, (2) ukazovateľ, (3) merná jednotka, (4) priemerný ročný stav, (5) priemerný denný prírastok, (6) vyskladňovacia hmotnosť, (7) nárast hmotnosti 1 ks v kategórií, (8) dĺžka odchovu 1 ks v kategórií, (9) predaj v kusoch, (10) tržná produkcia – vyskladnenie, (11) náklad na 1 kŕmny deň, (12) náklad na 1 kg prírastku, (13) náklad na odchov 1 ks v kategórií, (14) rozpočítaný náklad za úhyn na 1 vyskladnený kus, (15) celková nákladová hodnota pri predaji, (16) celková nákladová hodnota 1 kg živej hmotnosti, (17) tržná cena za 1 kg živej hmotnosti, (18) tržná cena 1 kusa, (19) zisk alebo strata pri predaji 1 kusa, (20) zisk alebo strata za celý chov

Table 6 Economic impact of price changes depending on variants

Serial no. (1)	Index (2)	Variant 1	Variant 2
1.	Calculated profit/loss for total pig breeding per 100 sows in implementing mean production and reproduction indices in 2004 was (3)	-1,312,545 Sk	0 Sk
2.	Increasing realisation price per 1 kg meat by 1 Sk shall increase profit/reduce loss of total breeding by (4)	171,005.18 Sk	216,635.33 Sk
3.	Reducing realisation price per 1 kg meat by 1 Sk would increase loss of total breeding by (5)	-171,005.18 Sk	-216,635.33 Sk
4.	Economic point of production reverse without grants shall occur if mean realisation price per 1 kg meat of fattened pigs shall increase by (6)	7.68 Sk	0 Sk

Tabuľka 6 Ekonomický dopad zmien ceny podľa variantov
(1) poradové číslo, (2) ukazovateľ, (3) vypočítaný zisk (strata) za celý chov ošípaných je na 100 prasníc pri implementovaných priemerných produkčných a reprodukčných ukazovateľoch v roku 2006 je, (4) zvýšenie realizačnej ceny za 1 kg mäsa o 1 Sk zvýši zisk (zníži stratu) celého chovu o, (5) zníženie realizačnej ceny za 1 kg mäsa o 1 Sk by prehĺbilo stratu celého chovu o, (6) ekonomický bod zvratu výroby bez dotácií nastane, ak sa priemerná realizačná cena 1 kg mäsa výkrmových ošípaných zvýši o

Table 7 Economic impact of price cost and utility changes

Serial no. (1)	Index (2)	Variant 1	Variant 2
1.	Economic impact of 1 % cost increase per 1 KD in total breeding is (3)	81 750,87 Sk	86 421,04 Sk
2.	Economic impact of 1 % cost increase in sow category (BH) is (4)	22,221.83 Sk	22,221.83 Sk
3.	Economic impact of 1 % cost increase per 1 KD in pig fattening category is (5)	59 362.00 Sk	63 991,62 Sk
4.	Economic impact of 0.01 kg mean daily increment in pig fattening category is (6)	102 224,08 Sk	93,970.68 Sk
5.	Economic impact of 0.01 kg decrease in mean daily increment in pig fattening category is (7)	-105 874,94 Sk	-96,818.28 Sk
6.	Economic impact of 1 pc increase of live born sucklings per 1 sow (8)	39 304,68 Sk	87 691,72 Sk

Tabuľka 7 Ekonomický dopad zmien nákladov a úžitkovosti
(1) poradové číslo, (2) ukazovateľ, (3) ekonomický dopad zvýšenia nákladov o 1 % na KD v celom chove je, (4) ekonomický dopad zvýšenia nákladov o 1 % v kategórií prasnice (ZS) je, (5) ekonomický dopad zvýšenia nákladov o 1 % na KD v kategórií výkrm ošípaných je, (6) ekonomický dopad zvýšenia priemerného denného prírastku o 0,01 kg v kategórií výkrm ošípaných je, (7) ekonomický dopad zníženia priemerného denného prírastku o 0,01 kg v kategórií výkrm ošípaných je, (8) ekonomický dopad zvýšenia počtu živo narodených ciciakov na 1 prasnicu o 1 kus

cost per total pig breeding by 15 % lower in the second variant compared with the first variant. These favourable economic results shall be shown in the final economic effect in that whereas the first variant has loss (re-calculated per 100 sows from the pig breeding) 1,312,545 Sk per year, the second variant keeps balance in management total and the whole breed is without losses.

Prices, costs and utility parameters are decisive indices of economic efficiency of production. Economic impact of their changes depending on the variants can be seen in Tables 6 and 7.

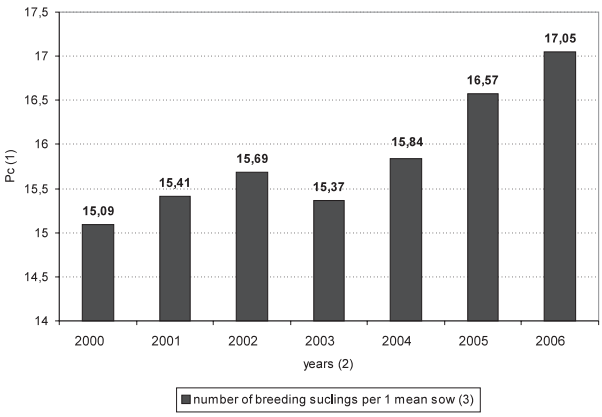
In the competition of EU countries such a high increase of price in variant 1 is not real. It could only occur in critical lack of pork caused by some breeding crisis, such as planary occurrence of pig plague that would significantly reduce the number of these animals.

The above economic impact of parameters evaluated in Sk (Slovak Crown) points at economic dependence of relations in improving or worsening of utility, cost and price indices to breeding economy.

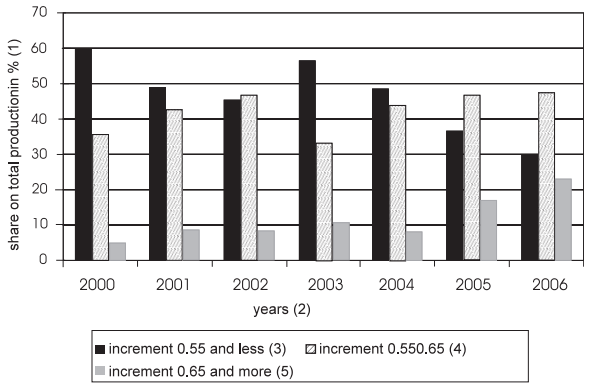
Based on model results, we can conclude that (calculated per 100 sows):

- increasing realisation price of fattening pigs meat by 1 Sk shall increase profit (reduce loss) of total breeding by 216,635.33 Sk,
- reducing realisation price by 1 Sk shall intensify loss of total breeding (reduce profit) by 216,635.33 Sk,
- economic impact of increased or reduced cost by 1 % per total breeding make 86,421.04 Sk,
- economic impact of increased or reduced cost by 1 % in sow category shall make 22,221 Sk,
- economic impact of increased or reduced cost by 1 % in pig fattening category shall make 63,991.62 Sk,
- economic impact of increasing mean daily increment by 0.01 kg in fattening category shall make 93,970.68 Sk,
- economic impact of reducing mean daily increment by 0.01 kg in fattening category shall make -96 818.28 Sk,
- economic impact of increasing number of live born piglets by 1 pc shall be 87,691.72 Sk.

These expected economic changes (in parametering bigger or smaller changes) of interval parameters of pig breeding shall be calculated dynamically, not as a multiple of change in



Graph 1 Breeding suclings per 1 mean sow
Graf 1 Počet odstavených prasiat na prasnicu v SR
(1) kusy, (2) roky, (3) počet odstavených prasiat na prasnicu



Graph 2 Share of pork production by increments in the Slovak republic in %

Graf 2 Percentuálny podiel produkcie bravčového mäsa podľa prírastkov v SR

(1) podiel na celkovej produkcii v %, (2) roky, (3) prírastok 0,55 a menej, (4) prírastok 0,55–0,65, (5) prírastok 0,65 a viac

changing parameter. The given theoretical calculation is based on mean SR indices.

In the graphs there is introduced the development of number of entities involved in pig breeding and development of productive and reproductive indices in Slovakia during 2000–2006 by the statistical reports, Agric. 1–12.

Every individual subject includes in his production conditions real costs, production and reproduction indices, whose result is pork production at varying cost level. Market price of meat, that the producers cannot influence, shall always be an instrument determining parameters of production and competitiveness.

Negative impact of incessant pressure on reducing prices of carcass animals has been emphasised by Grimek (2005). This fact results in reducing the number of carcass animal producers.

Model calculation has shown what production and reproduction indices shall have to be achieved by Slovak breeders in their breeding so as to be economically competitive confronted with EU market prices, i.e. not to be selling the meat produced with loss. Hence the following level of indices shall have to be achieved:

- increment in pig fattening minimum 0.67 kg per fattening day (from fattening inclusion weight, i.e. 8.50 kg up to slaughter weight, i.e. 107 kg),
- mortality rate in pig fattening maximum 4 %,
- number of live-born sucklings per 1 sow per year minimum 23.63 pcs,
- suckling mortality rate (from birth to fattening transfer) maximum 9 %.
- Other breeding and economic parameters to be achieved for securing pig competitiveness are included in greater detail in previous tables.

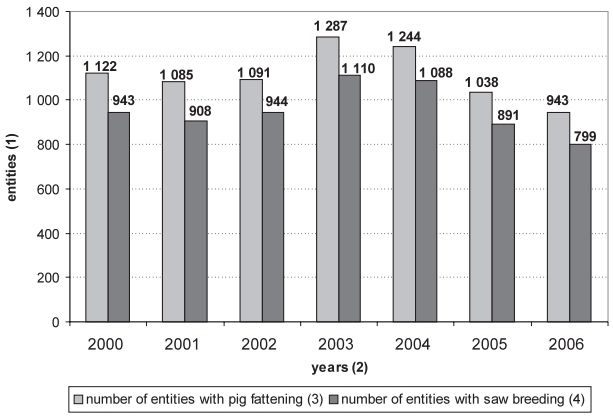
Similar conclusions have also been achieved by Hudák (2001); according to him Slovak pigs, pork and meat products are highly incompetitive in EU markets. This is mainly caused by higher cost of production and lower labour productivity in pig breeding in Slovakia. Ižáková (2001), based on similar analysis of competitiveness of particular agricultural and foodstuff products, also claims that significantly incompetitive in EU markets are our pork products.

The above limits of production and reproduction indices in present-day Slovakia are only achieved by a relatively small rate of farms here. Pertinent data analysed for the year 2006 prove that Slovakia produced 111,640 tons of pork, of which breeds exceeding 0.65 kg per piece per day achieved 25,677.2 tons, which only makes 23 %. Based on this we can claim that up to 77 % of carcass pigs are produced inefficiently (with loss). Concerning live-born and weaned piglets, the situation is even slightly worse. In 2006 SR ran 799 farms with sow breeding, of which only 131 (i.e. 16.4 %) has weaning more than 18 piglets per sow per year. It should be, however, added that higher weaning (above 18 pcs) was achieved predominantly in farms with higher sow concentration (200 and more pcs), as these produce up to 48.8 % of all piglets. This means that a great number of farms (708) bread small numbers of sows with low reproduction parameters, so that pig production here is unprofitable.

The abovementioned facts bring evidence on the unprofitability of the whole branch of pig breeding in Slovakia. This has also been confirmed by the results of cost analysis undertaken by VÚEPP (Research Institute of Pig Breeding) in Bratislava at a selected set of farms (Kubánková, 2006). The results show that in 2005 mean losses in sow breeding in Slovakia was -22.07 Sk per fattening day, and profitability 2.16 Sk calculated per 1 kg increment in pig fattening.

Lower level of pig utility parameters in Slovakia compared with developed countries also results from data by Borecká (2005). In 2006, as compared with 2004, the number of live born piglets per sow per year may have grown (18.75 pcs), along with the number of weaned (17.06 pcs) piglets per sow per year, and increased mean daily increments in pig fattening to 0.568 kg.pc^{-1}, yet, Slovakia lags behind significantly, even compared with elder data (Hetényi, 2000). The number of weaned piglets per sow and year in Germany was 18.6 pcs, in Denmark even 22 pcs. Mean daily increment in pig fattening in Germany was 640 g, in Denmark even 730 g per piece.

A factor not to be overlooked, that also negatively influences the situation in pig breeding is the reinforcement of the Slovak crown (Sk) in recent years. As a result of the growing Sk : € course, the unit price of imported goods recalculated to Sk gets reduced. Our processors pay ever less for imported pork and/or carcass pigs from other EU countries. This fact has a retarding effect on carcass pig prices in home market. For the SR post-accession period to EU,the Sk : € course improved



Graph 3 Number of entities with pig fattening and saw breeding

Graf 3 Počet subjektov, ktoré majú výkrm ošípaných a ktoré chovajú prasnice

(1) subjekty, (2) roky, (3) počet subjektov, ktoré majú výkrm ošípaných, (4) počet subjektov, ktoré chovajú prasnice

by 4.24 Sk (from 41.491 Sk : € in 2003 to 37.248 Sk : € in 2006). For the same period the unit price of pigs in Slovakia only increased by 2.63 Sk per kg live weight (from 37.48 Sk.kg^{-1} in 2003 to 40.11 Sk.kg^{-1} in 2006) and reaches average EU price level (in 2006+ it was 1.13 € per kg).

The above facts should be realised by managers deciding on the extent of breeding sow and carcass pigs in farms and specialised enterprises. Primarily, it shall be necessary to proceed from the realisation prices of carcass pigs that are established in the market irrespective of the particular enterprise; the other side is influenced by the cost level of sow breeding, including subsequent pig categories, that is individual and partly influencible by enterprise measures. It is, of course, necessary to consider real possibilities of achieving the level of production and reproduction parameters of breeding in line with particular technical-technological solution of breeding, quality and quantity of forage provision, genetical utility prerequisities of animals and professional level of labour forces in breeding. All these factors should be combined with the concurrent use of most seasonal moves in prices of carcass pigs in the course of the year (in general, prices are highest in autumn) so as to achieve the most favourable economic effect of the whole pig breeding.

Súhrn

Situácia v chove ošípaných v Slovenskej republike je dlhodobo nepriaznivá. Neustále klesajú početné stavy ošípaných, znižuje sa počet producentov, zvyšuje sa dovoz ošípaných i bravčového mäsa z iných krajín EÚ. Je to výsledok prehlbujúcej sa stratovosti chovu ošípaných. Možnosti nápravy a ďalšieho vývoja naznačuje príspevok. Pomocou optimalizačného modelu kvantifikuje dopad zmien nákladov, realizačných cien, produkčných a reprodukčných ukazovateľov na ekonomické výsledky chovu. Na základe toho stanovuje úroveň príslušných výrobných a ekonomických parametrov tak, aby chov ošípaných nebol stratový.

Kľúčové slová: optimalizačný model, chov ošípaných, produkčné ukazovatele, náklady, ceny

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Acta oeconomica et informatica 2
Nitra, Slovaca Universitas Agriculturae Nitriae, 2008, s. 35–39

AGRICULTURE PRODUCTIVITY INDICATORS AND IMPACT OF ENVIRONMENTAL CHANGE ON CEECS AGRICULTURE

UKAZOVATELE POĽNOHOSPODÁRSKEJ PRODUKTIVITY A DOPAD ENVIRONMENTÁLNYCH ZMIEN NA POĽNOHOSPODÁRSVO KRAJÍN CEES

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The agriculture has an outstanding importance both in social and economic point of view, especially in the countries where the agriculture plays a vital role in economy. This paper mainly focuses on the situation in the Central and Eastern European countries (CEECs). The share of agriculture in CEECs is more significant both in GDP and employment than in the old member states of EU. To be competitive on the single market, we have to know the advantages and disadvantages, strength and weakness of different sectors of agriculture. Traditionally, in these countries to measure the effectiveness, the partial factor analyses are used. To get more accurate overview, we need to use more wide technique to sampling measurement. The presenting paper summarizes the measurement techniques of effectiveness with environmental impacts on agriculture and examine, which one from them can be used in CEECs according to the available data.

Key words: sustainability, effectiveness, environment, agricultural policy, factor analysis

Agricultural production differs from other sectors of the economy, such as industry and services, because it is dependent on the life cycles of plants and animals, on the seasons and climates, on the fertility of the soil, water supplies and so on. Agriculture is at the base of the food chain. This sector is thus fundamental. The first objective of agriculture is to produce food for people and animals. It also supplies nonfood products, for example row material for other industries. It must respect production standards (traditional or organic) and ensure the quality and safety of foods. As well as their role in producing the foodstuff which support all life, farmers also play an important part in caring for the environment, to the extent that they are in the front line for preserving the wealth of landscapes and biodiversity. Farmers also contribute also to the dynamism of rural areas and to the maintenance of balanced land development:

- they ensure the conservation of landscapes and paths, and the maintenance of forests and grassland to limit natural disasters,
- they preserve European biodiversity, flora and fauna,
- they fight against the rural exodus and overpopulation in towns,
- they stimulate rural development and the expansion of infrastructure in rural areas,
- they maintain economic activities in areas with low density population and create jobs in rural areas.

Summarizing, the agriculture is one of the main contributors of human welfare in different aspects.

The endeavors to increase the agricultural productivity can be found in almost every country's the long term national economy purposes. The reasons are wide due to the differences among countries together with the differences in historical periods. In recent decades the instruments of economy policy that affect agricultural productivity have had significant role especially in the developed countries, where the policies supporting intensive agricultural production caused overproduction, unfavorable resource allocation and significant welfare damages.

Agricultural production and trade is debated issue on WTO, UN, and FAO. The agreements effect the performance of agriculture in developing countries, which have low level of self-sufficiency.

Motivation of research on agricultural productivity in CEECS

The examination is focused on the situation of agriculture in CEECs, which follows many specialties:

- CEECs went through the transition from centrally planned economy to market economy.
- Agricultural sector represents a high share in the total GDP.
- High share of agriculture in total employment (Figure1).
- EU membership and applying for Common Agricultural Policy (CAP).

With enlargement, 4 million farmers have joined the 7 million already existing ones in the Europe of 15. In the new Member States, agriculture provides on average three times more jobs than in the Europe of 15 (13.4 % in the new Member States as against 4 % in EU-15). This percentage is even higher in Bulgaria and Romania who will join the EU later (Agriculture in the new member states of the EU, 2004).

Agriculture in the CEECs tends to have a dual structure. On the one hand, there are large businesses, some of which are cooperatives, which have appeared during the re-organization of agriculture, generally cultivating in excess of 1000 hectares of land. These enterprises are generally market-oriented. Nevertheless, the methods of production they use are often far from efficient. It may be, therefore, that these businesses will undergo further restructuring and that their importance will diminish. On the other hand there are also small family farms that most often aim principally to feed the family. These farms are now faced with technological and financial pressures. However, they could well evolve in the future into a class of private farmers focusing on the markets. Family farms of middling size, integrated into the market, are also emerging, though they remain in a minority.

Figure 1 Role of agriculture in the CEECS

Land (1)	UAA in km^2	UAA % total area (2)	GAV € milions	Agriculture as % GDP	Agricultural employment (3)	Agricultural employment as % employment (3)
Estonia (4)	6,983	15	175	2.2	38,000	6.5
Latvia (5)	15,955	25	211	2.1	151,000	15.3
Lithuania (6)	29,025	44	421	2.6	265,000	18.6
Poland (7)	168,912	54	4,209	2.3	2,713,000	19.6
Czech Republic (8)	36,522	46	866	1.1	232,000	4.9
Hungary (9)	63,259	68	1,953	2.7	233,000	6.1
Slovakia (10)	22,364	46	354	1.2	139,000	6.6
Slovenia (11)	5,047	25	387	1.6	89,000	9.7
Cyprus (12)	1,367	15	423	3.7	17,000	5.4
Malta (13)	97	31	69	1.6	3,000	2.1
EU-15 (14)	1,265,402	39	148,491	1.6	6,537,000	4.0
New Member States (15)	354,177	53	9,069	2.3	3,880,000	13.4
EU-25 (16)	1,619,579	42	157,560	1.6	10,417,000	5.4
Bulgaria (17)	53,247	48	1,532	8.7	299,000	10.7
Romania (18)	148,190	62	5,653	11.2	3,683,000	37.7

Sources: Agriculture in the new member states of the EU (2004)
UAA – utilised agricultural area, GAV – gross agricultural value

Obrázok 1 Úloha poľnohospodárstva v krajinách CEES
(1) krajina, (2) celková plocha, (3) zamestnanie v poľnohospodárstve, (4) Estónsko, (5) Lotyšsko, (6) Litva, (7) Poľsko, (8) Česká republika, (9) Maďarsko, (10) Slovensko, (11) Slovinsko, (12) Cyprus, (13) Malta, (14) EU-15, (15) nové členské štáty, (16) EÚ-25, (17) Bulharsko, (18) Rumunsko

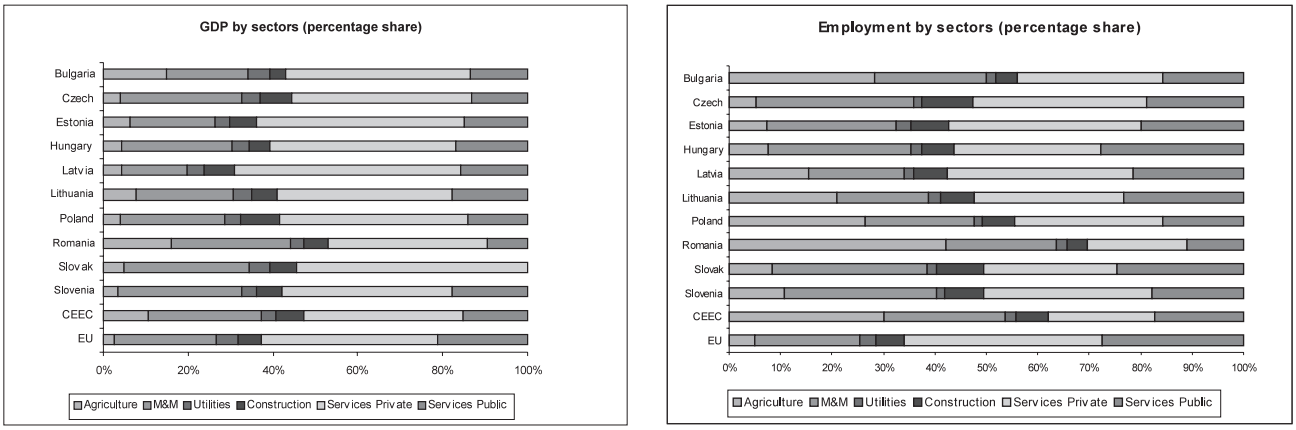

Figure 2 Share of agriculture in the economy
Source/Zdroj: Fekete-Farkas et all. (2004)

Obrázok 2 Podiel poľnohospodárstva v ekonomike
(1) HDP podľa sektorov (percentuálny podiel), (2) Bulharsko, (3) Česká republika, (4) Estónsko, (5) Maďarsko, (6) Lotyšsko, (7) Litva, (8) Poľsko, (9) Rumunsko, (10) Slovensko, (11) Slovinsko, (12) CEEC, (13) EÚ, (14) poľnohospodárstvo, (15) kovovýroba a strojárstvo, (16) komunálne služby, (17) stavby, (18) súkromné služby, (19) verejné služby, (20) zamestnanosť podľa sektorov (percentuálny podiel)

Despite the fact that agriculture in CEECs' was one of the first sectors hurt by the economic reforms, its importance in and consequences for national economy are still stronger that in the majority of the EU-15 as shown in the Fig. 2.

Agricultural Productivity Indicators

The two main objectives of the Common Agricultural Policy (CAP) of the EU are designed to increase agricultural productivity and to provide fair standard of living for the agricultural community.

Reflecting on the reforms in the CAP introduced under the title 'Agenda 2000', the Eurostat embarked on the development of new agricultural productivity indicators, which caught the attention of both politicians and analysts.

The Economic Accounts for Agriculture (EAA), revised in 1997, and the closely related Agricultural Labour Input (ALI) statistics provide a consistent framework for defining the productivity indicators. The so-called agricultural income indices, regularly derived from EAA and ALI statistics, are in fact productivity indicators, which measure the state of the sector (Szabo, 2003).

Productivity, which measures the increase in outputs not accounted for by the growth in production inputs, is a closely watched economic performance indicator because of its contribution to a healthy and thriving economy. Agriculture in particular has been a very important sector in every country's economy in terms of productivity growth. Productivity growth in

agriculture can be attributed to the investments in research and development (R&D), extension, education, and infrastructure. Increased productivity can translate into increased farm income, at least in the short run. In the long run, additional farms adopt the more productive inputs and practices, leading to increased output supply and a possible lowering of farm output prices and farm income (Jet et al., 2000).

Productivity indicators can be classified **into three categories:**

1. partial productivity: relates an output indicator to a single input indicator,
2. multi-factor productivity: relates every output indicator to a bundle of input indicators,
3. Total factor productivity: occurs when the ratio of total outputs to total inputs increases, reflecting greater average output per unit of input.

These types have their advantages and disadvantages. Partial productivity is easy to measure and understand but it does not reflect the fact that in reality output can be dependent on the interaction of several production factors. The partial productivity is proposed as a secondary indicator only, mainly for comparing different industries within a single member state. Multi-factor productivity is much better at that point but it requires a substantial amount of input data (Ball et al., 2001, Carter et Zhang, 1994).

The multi-factor productivity indicators have been given greater priority, because they allow a better comparison among the member states.

Several facts must be taken into account when analyzing these indicators:

- Output refers only to production in the physical sense, but there are social and environmental factors as well (such as desertification etc.).
- Depreciation, used in the weighting of capital, may require empirical correction.
- The labour input data are not broken down by age, sex and education.

Partial productivity measures

Historically, economists have used and developed productivity measures based on the relationship between one or more outputs relative to a single key input, such as an acre of farm land or an index of farm labor input. These indicators are called partial factor productivity indicators. The most common partial productivity index economy-wide is a labor productivity measure.

The Table 1 shows the Gross Agricultural Production (GAP) per 1 ha Utilised Agricultural Area (UAA) in Bulgaria, the Czech Republic, Hungary, Poland, Romania and Slovakia (in EUR/ha, and percent of EU average) in crops, livestock and total. In the analyzed countries this ratio reflects between app. 20–40% (in both of areas and in total). This percentage is the highest in Hungary, in the Czech Republic and Poland is average, and in other countries lower.

Table 1 Gross Agricultural Production (GAP) per 1 ha UAA in 2000

	EU-15	BG	CZ	H	PL	RO	SK
Crops (1)							
EUR/ha	1,121	246	274	371	303	336	233
% of EU	100	22	24	33	27	30	21
Livestock (2)							
EUR/ha	806	236	308	311	269	182	271
% of EU	100	29	38	39	33	23	34

Source/Zdroj: Novak et al, 2005

Tabuľka 2 Hrubá poľnohospodárska produkcia (HPP) na 1 ha využívanej poľnohospodárskej pôdy v roku 2000
(1) poľnohospodárske plodiny, (2) dobytok

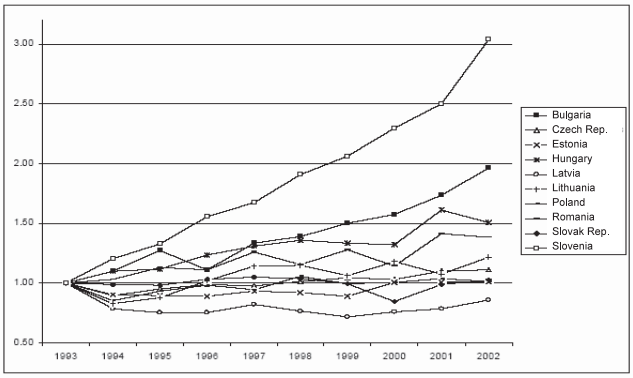

Figure 3 Changes in Agricultural Labour Productivity (ALP) for the Ten CEECs (base 1993 = 1
Source/Zdroj: Tonini, 2005

Obrázok 3 Zmeny produktivity práce v poľnohospodárstve (PPP) desiatich krajín CEEC (základ 2003 = 1
(1) Bulharsko, (2) Česká republika, (3) Estónsko, (4) Maďarsko, (5) Lotyšsko, (6) Litva, (7) Poľsko, (8) Rumunsko, (9) Slovenská republika, (10) Slovinsko

Figure 3, describes the changes in agricultural labour productivity (agricultural output per economic active person) for the ten CEECs for the period 1993–2002. In spite of the contemporaneous agricultural output and labour input contraction in the majority of the CEECs it is possible to envisage a rise in agricultural labour productivity (APL) for several countries such as Bulgaria, Hungary, Romania and Slovenia. This underlines the fact that in these countries labour input went down faster then agricultural output.

Total Factor Productivity Measure

The traditional measurement techniques of effectiveness, both in partial and complex efficiency indexes (TFP – total factor productivity), are calculated only with those factors that have direct linkage with the agricultural production and can be measured in market transactions.

TFP index derives change in total output relative to the change in the use of all inputs. It is usually preferred to the simplier partial productivity measures that may provide misleading results especially when the countries are characterized by asymmetric changes in inputs (i.e. CEECs) (Roselle and Swinnen, 2004).

The Malmquist index of Total Factor Productivity (TFP)

Since agriculture is potentially an important contributor to environmental degradation, in agriculture it may be especially important to adjust productivity measures to reflect environmental impacts. Measurement of productivity is important, but it is not an unambiguous task, especially when un-priced (or poorly priced) inputs or outputs are involved. Recent years have seen growing importance of non-parametric approaches in the computation of agriculture productivity (especially the Malmquist productivity index) and environmental impacts.

The MI in comparison to the widely used Tornqvist Index (TI) is more adequate when measuring TFP growth for CEECs for several reasons (Macours & Swinnen, 2000a,b). First, the

Table 2 Average annual changes 1993–2005 in CEECs

Country (1)	Efficiency change (EC) (2)	Technical change (TC) (3)	TFP change (4)
Bulgaria (5)	0.9999	1.0036	1.0035
Czech Rep. (6)	0.9996	1.0031	1.0027
Estonia (7)	0.9991	1.0024	1.0014
Hungary (8)	1.0000	1.0037	1.0036
Latvia (9)	0.9991	1.0019	1.0011
Lithuania (10)	0.9993	1.0029	1.0022
Poland (11)	0.9992	1.0034	1.0027
Romania (12)	0.9994	1.0034	1.0029
Slovak Rep. (13)	0.9996	1.0027	1.0023
Slovenia (14)	0.9995	1.0053	1.0048
Weighted average (15)	0.9995	1.0034	1.0029

Source/Zdroj: Tonini, 2005

Tabuľka 2 Priemerné ročné zmeny 1993–2005 v krajinách CEEC
(1) krajina, (2) zmena v efektivite, (3) technická zmena, (4) zmena v celkovej faktorovej produktivite, (5) Bulharsko, (6) Česká republika, (7) Estónsko, (8) Maďarsko, (9) Lotyšsko, (10) Litva, (11) Poľsko, (12) Rumunsko, (13) Slovenská republika, (14) Slovinsko, (15) vážený priemer

MI is less restrictive than the Tornqvist Index (TI) because it does not assume that the units under observation are contemporaneously technically and allocatively efficient, permitting to measure the degree under which countries move towards or further away from the given technology. It is arguable and restrictive to consider that units are contemporaneously technically and allocatively efficient during a dynamic process of resource adjustments such as the transition reform. Second, the MI does not necessarily require the imposition of strong behavioral assumptions that may be questioned for country level analysis. Third the MI does not require input prices that for CEECs may be only sparsely available, and when available they are frequently affected by hyperinflation making arguable their use. Finally the MI allows the TFP growth to be decomposed into technical change and efficiency change, making possible to distinguish between different sources of productivity growth over time.

According to Tonini (2005) TFP calculation, the results of TFP growth in agriculture for the ten CEECs show an average annual growth in agricultural total factor productivity of 0.29 per cent, with a negative efficiency change contributing 0.05 per cent per year, and technical change contributing 0.34 per cent per year. This implies for the ten CEECs an overall limited and moderate growth of TFP in agriculture entirely driven by technical change. The moderate agricultural productivity growth has to be observed in perspective.

The Tornqvist-Theil index of Total Factor Productivity (TFP)

There is a useful equivalency between the Malmquist productivity index and the commonly used Tornqvist-Theil (TT) productivity index. Caves, Christensen, and Diewert (CCD) in 1982 stated that when technologies are represented by certain functional forms, a Tornqvist-Theil index computed with shadow shares calculated from the Malmquist shadow prices provides the same productivity measure as the CCD version of the Malmquist.

A Tornqvist index is currently used to estimate agricultural productivity. In the past, the Laspeyres index, which uses base-period weights, was used in contrast to the Tornqvist, which uses prices from both the base period and the comparison period. The Tornqvist is preferred to the Laspeyres because it does not require the unrealistic assumption that all inputs are perfect substitutes in production.

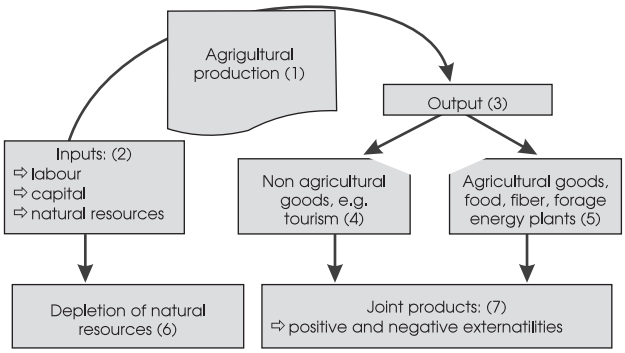

Figure 4 Total value of agricultural production
Obrázok 4 Celková hodnota poľnohospodárskej produkcie
(1) poľnohospodárska produkcia, (2) vstupy (práca, kapitál, prírodné zdroje), (3) výstup, (4) produkty nepoľnohospodárskeho charakteru, napr. turizmus, (5) poľnohospodárske tovary, potraviny, vláknina, krmoviny, energetické plodiny, (6) vyčerpanie prírodných zdrojov, (7) spojené produkty: pozitívne a negatívne externé efekty

Total Social Factor Productivity Measure

Conventional measures of total factor productivity (TFP) do not take into account inputs and outputs that are external to the production process, i.e. they only include the factors that are managed by decision makers, and do not include possible externalities that might arise from that process. Intuitively then it seems appropriate to include these negative (or positive) external effects within an amended measure of agricultural TFP to produce a measure of total social factor productivity (TSFP) that attempts to measure the full social costs and benefits of agricultural production showed in the Figure 4.

The TSFP index, which is calculated considering external effects, shows the complex social efficiency. It is highly accepted by many economists as an important index of sustainable development. Socially it is expected to increase productivity in such a way that no one from the mentioned indexes decreases (Gorton & Davidova, 2004).

The **social value of agricultural production** can be expressed with the following equation:

$$W = TU + \Delta NS$$

where:
TU – usefulness from the consumption of agricultural products and services,
ΔNS– devaluation of natural resources (present value of long time services' decrease)

Factors Affecting Agricultural Productivity

Several factors have been identified in the social science literature as the most important sources of productivity change in agriculture: research and development, extension, education, infrastructure, and government programs. Productivity measures do not provide any information about the separate role of each of these factors. However, understanding of potential sources of productivity growth is important for formulating appropriate policy tools to increase productivity and a society's standard of living.

Conclusion

The agricultural sector in Central and Eastern Europe is confronted by three huge problems simultaneously: (i) transition process, (ii) competitiveness in the single market of EU, and (iii) sustainability. Productivity increase and welfare are main issues of future development pathway in the agriculture. Improving total factor productivity helps to reach the above-mentioned goals. Institutions and social capital are very important for the performances of the government, the economy as a whole, and sustainable agriculture (with transaction cost of sustainability). Enlargement of the EU had important impacts on the structure of agriculture in the CEEC region. It is likely to have some further effects on agriculture and agricultural policies in the future. One important factor could be on policy-making (CAP), at least because agreeing on important reforms will be even more complicated with 25 Member States than it was with 15, and also according to the requirements of sustainability.

Súhrn

Poľnohospodárstvo má výnimočné postavenie, či už zo sociálneho alebo ekonomického hľadiska najmä v tých krajinách, v ktorých hrá rozhodujúcu úlohu v ekonomike. Tento príspevok sa sústreďuje najmä na situácie v krajinách strednej a východnej Európy (CEEC). Podiel poľnohospodárstva v krajinách CEES je pokiaľ ide o ukazovateľ HDP, aj nezamestnanosť výraznejší ako v starých členských štátoch EÚ. Za účelom dosiahnutia konkurencieschopnosti na jednotnom trhu je potrebné poznať výhody a nevýhody, silné a slabé stránky poľnohospodárskeho sektora. Na meranie efektivity sa v týchto krajinách tradične používajú faktorové analýzy. Na získanie presnejšieho prehľadu je potrebné použiť širokospektrálne metódy. Tento príspevok sumarizuje spôsoby merania efektivity s environmentálnym dosahom na poľnohospodárstvo a skúma, ktorá z nich by mohla byť podľa dostupných údajov použitá v krajinách CEEC.

Kľúčové slová: trvalá udržateľnosť, efektivita, životné prostredie, poľnohospodárska politika, faktorová analýza

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Acta oeconomica et informatica 2
Nitra, Slovaca Universitas Agriculturae Nitriae, 2008, s. 40–45

RESTRUCTURING AND COMPETITIVENESS OF DAIRY PRODUCTION IN SLOVENIA

REŠTRUKTURALIZÁCIA A KONKURENCIESCHOPNOSŤ SLOVINSKÉHO MLIEKARSTVA

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This paper analyses market developments in the Slovenian dairy sector focusing on market restructuring, milk quality improvements and competitiveness of milk production. The dairy markets and dairy processing in Slovenia have undergone structural adjustment changes and harmonisation of quality standards towards the European Union (EU) standards with implications for domestic dairy markets. Slovenia has remained a net exporter of dairy products. With the introduction of comparable EU quality standards the share of marketed milk production and the quality of purchased milk have increased substantially. The relatively low yield per cow has increased, because cow milk production is concentrated towards more efficient family farms. A shift in milk production from family household's subsistence needs towards more productive and efficient larger family farms specialized in milk production has caused a greater commercialisation and concentration of cow milk farms with a reallocation of existing factors in the pre-existing dairy sector.

Key words: dairy, restructuring, competitiveness, quality improvements

The dairy cow sector in Slovenia has been traditionally considered as a key agricultural sector. This crucial role of the dairy cow sector has been determined by both the subsistence nature of production on family farms in the past and later its important role for cash inflows in the family farms with the milk production commercialisation. The dairy products has been sold on domestic market and exported particularly on a traditional former Yugoslav markets. In spite of a fact that some trade diversion effects have occurred on these markets after the collapse of the former Yugoslavia, Slovenia has remained a net exporter of dairy products.

The dairy markets and dairy processing in Slovenia have undergone substantial adjustment changes and harmonisation of quality standards towards the European Union (EU) standards. During these adjustment and harmonisation processes, the Slovenian dairy sector has experienced considerable structural changes with implications for domestic dairy markets. Similar to Poland and the other former Yugoslav countries, also in Slovenia the majority of small-scale agricultural households have been traditionally engaged in milk production for subsistence needs of family members. With transition to a market economy liberalization of domestic markets, part-time and subsistence farming have deteriorated in their importance. Domestic dairy production in the past has been protected, which caused the lower level of international competitiveness and the lower degree of international trade integration (e.g. Bojnec, 1999; 2001). Nominal and effective protection rates for dairy products have been relatively high, while international competitiveness measured by domestic resource costs indicated a lack of international competitiveness. Trade liberalization and the process of integration of Slovenia into EU induced pressures for restructuring with exit of less viable and efficient dairy cow farms. With the introduction of the comparable EU quality standards the purchased cow milk of higher quality has increased substantially. With the exit of traditional, smaller family milk producers, the commercialisation and concentration of dairy farms have increased towards more productive and efficient larger family farms specialized in cow milk production. Therefore, one considerable change observed during the most recent years, there is a shift in cow milk production from family household's subsistence needs towards a greater specialization and commercialisation of dairy cow family farms. The share of marketed cow milk production outside the family households has increased. With the increased quality requirement standards to comply with the EU requirements, a deeper market selection process among dairy family farms has been induced (Klopčič and Valjavec, 2001; Klopčič et al., 2001). The quality of cow milk delivered to dairies has increased. At the same time, considerable reallocations of existing production factors on dairy farms have occurred. We present material and methods that are used in this paper. After then we present evidence on market developments in the Slovenian dairy cow sector focusing on restructuring, quality improvements and competitiveness to provide discussion on lessons learned and policy implications.

Material and methods

The Policy Analysis Matrix (PAM) is often used approach to estimate protection, policy transfers and competitiveness on a certain market. The PAM compares revenues, costs of traded intermediary inputs, costs of non-traded intermediary inputs and primary domestic resources (land, labour, and capital), and profitability (the difference between the revenue and all costs) at private (domestic) and economic (social) prices (Monke and Pearson, 1989). The PAM structure, indicators of profitability at private (domestic) prices and economic (shadow or social) prices, measures of protection and competitiveness are described in Table 1.

The level of protection is presented on the basis of nominal protection rate (NPR) and effective protection rate (EPR), while efficiency and international competitiveness on the basis of domestic resource costs (DRC) measure. NPR greater than zero (0%) indicates implicit nominal protection or subsidy by producers, and implicit nominal tax, when NPR is less than 0%.

Table 1 Policy Analysis Matrix (PAM), indicators of profitability, protection, and efficiency

	Revenue (1)	Traded intermediary costs (2)	Primary domestic resource costs (3)	Profitability (4)
Private (domestic) prices (5)	A	B	C	D = A – B – C
Economic (shadow) prices (6)	E	F	G	H = E – F – G
Policy transfers (7)	I = A – E	J = B – F	K = C – G	L = D – H = I – J – K

Private profitability (8)	D = A – B – C
Economic profitability (9)	H = E – F – G
Transfers to output (10)	I = A – E
Transfers to traded intermediary inputs (11)	J = B – F
Transfers to primary domestic resources (12)	K = C – G
Net transfers (13)	L = D – H = I – J – K
Nominal protection rate (NPR) (14)	NPR = [(A / E) – 1]*100
Effective protection rate (EPR) (15)	EPR = [((A–B)/(E–F)) – 1]*100
Social cost-benefit ratio (SCBR) (16)	SCBR = (F+G)/E
Domestic resource cost (DRC) (17)	DRC = G/(E–F)
Private cost ratio (PCR) (18)	PCR = C/(A–B) or G/(A–B)

Sources/Zdroj: Monke and Pearson, 1989; Tsakok, 1990; Bojnec, 2001

Tabuľka 1 Matica analýzy politík (PAM), indikátory rentability, ochrany a efektivity
(1) výnosy, (2) obchodné prechodné náklady, (3) primárne náklady na domáce zdroje, (4) ziskovosť, (5) súkromné (domáce) ceny, (6) ekonomické (tieňové) ceny, (7) transfery, (8) súkromná rentabilita, (9) ekonomická rentabilita, (10) transfery výstupu, (11) transfery obchodovateľným prechodným vstupom, (12) transfery primárnym domácim zdrojom, (13) čisté transfery, (14) nominálna miera ochrany, (15) miera efektívnej ochrany, (16) ukazovateľ prínosov sociálnych nákladov, (17) náklady domácich zdrojov, (18) ukazovateľ súkromných nákladov

EPR greater than 0% implies effective protection of value-added by producers, and effective taxation of value added by producers, when EPR is less than 0%. When DRC is less than 1, but greater than 0, this implies internationally competitive production. On the contrary, DRC greater than 1 implies that a certain product is not competitive internationally. Moreover, when DRC is less than 0, this implies very unprofitable, internationally loss-making activity.

The degree of external integration is measured by intra-industry trade (*IIT*). Similar product is often exported and imported at the same time. Trade in the same product group is in literature known as IIT in comparison with inter-industry trade. The weighted Grubel-Lloyd (1975) index of intra-industry trade (*GLIIT*) is defined:

$$GLIIT_i = \left(1 - \frac{\sum_j \left|X_{ij} - M_{ij}\right|}{\sum_j (X_{ij} - M_{ij})}\right) \cdot 100$$

where X_{ij} and M_{ij} are values of exports and imports respectively of a five-digit Standard International Trade Classification (SITC) product j of two-digit SITC product group i. GLIIT is defined between 0 and 1 (or between 0% and 100%). GLIIT is equal 0 when all trade inside product group i is inter-industry type (for example, only exports or only imports). GLIIT is equal 1 (100%) when all trade inside product group i is intra-industry type (for example, exports is equal imports).

The quality of traded products and the quality differences in IIT are assessed by the use of unit value of exports to unit value of imports. The export f.o.b. unit value (UVX_{ij}) and the import c.i.f. unit value (UVM_{ij}) are derived on the basis of export (import) values and export (import) quantities of a given five-digit SITC product j of two-digit SITC product group i. The ratio of the export to import unit values per tone ($IAATT_{ij}$) for a particular product j at the five-digit SITC level in the two-digit SITC group i is defined as:

$$IAATT_{ij} = \frac{UVX_{ij}}{UVM_{ij}}$$

The weighted unit values of matched exports ($UVMX_i$) and the weighted unit values of matched imports ($UVMM_i$) at the two-digit SITC product group i are defined as:

$$UVMX_i = \sum_j UVMX_{ij}\left(\frac{LIIT_{ij}}{LIIT_i}\right)$$

where the weight is the level of IIT of product j in group i ($LIITi_j$) in total level of *IIT* of product group i ($LIIT_i$). The ratio between the $UVMX_i$ and $UVMM_i$ is defined as:

$$UVMM_i = \sum_j UVMM_{ij}\left(\frac{LIIT_{ij}}{LIIT_i}\right)$$

which is an indicator of the relative quality of exports vis-ŕ-vis imports (e.g. FAO, 1999)? A ratio, which is greater than one indicates that matched export is more expensive (of higher quality) than matched import, but vice versa, when the ratio is less than one. Export-to-import price ratio close to one indicates that export price is equal to import price of a similar product, which suggests that there is no substantial quality difference between exported and imported product.

Results and discussion

We first present farm-gate milk prices and competitiveness in dairy products in Slovenia. Milk prices at farm gate level (milk collection centres) in current nominal Slovenian tolars (SIT) terms increased up to 2002, when in Slovenia was recorded the maximum level of cow's milk production. However, in current nominal Euro terms the highest average cow's milk price was already achieved in 2001. Since then we can see the decline in the average cow's milk price in current nominal Euro terms. The

Table 2 Farm-gate prices of cow's milk in Slovenia

Years (1)	Average price of cow's milk (SIT per unit of measure) (2)	Exchange rate SITs for 1 Euro (3)	Average price of cow's milk (Euro per unit of measure) (4)
1989	544	3.2266	169
1990	3,485	14.3895	242
1991	6,304	34.0177	185
1992	20,965	105.0788	200
1993	27,684	132.2802	209
1994	36,227	152.3622	238
1995	39,335	153.1177	257
1996	42,016	169.5098	248
1997	48,077	180.3985	267
1998	54,443	186.2659	292
1999	56,169	193.6253	290
2000	59,490	205.0316	290
2001	64,840	217.1851	299
2002	65,560	226.2237	290
2003	66,100	233.7045	283
2004	65,500	238.8615	274
2005	65,000	239.6371	271

Note: In 1990, the denomination of the former Yugoslav dinar for four zeros was carried out. The unit of measure for milk is per 1000 litres
Sources: Statistical Office of the Republic of Slovenia for average prices, and Bank of Slovenia, Monthly Bulletin, for the exchange rate Slovenian tolars (SIT) for 1 Euro

Tabuľka 2 Ceny kravského mlieka pri výstupe z poľnohospodárskej prevádzky (farm-gate) v Slovinsku
(1) roky, (2) priemerná cena kravského mlieka (slovinský tollar na mernú jednotku), (3) výmenný kurz slovinského toliara (SIT) k Euro, (4) priemerná cena kravského mlieka (Euro na mernú jednotku)

Table 3 Indicators of protection, policy transfers and international competitiveness in Slovenia

	Producer Subsidy Equivalents (PSE in %)[1/] (1)							
Years (2)	1992	1993	1994	1995	1996	1997	1998	1999
Milk (3)	48	46	50	48	42	47	59	55

	Nominal and Effective Protection Rates (3)								Domestic Resource Costs (DRC) (4)			
	NPR in %				EPR in %							
Years (2)	1995[2/]	1995[3/]	1997[3/]	1998[4/]	1995[2/]	1995[3/]	1997[3/]	1998[4/]	1995[2/]	1995[3/]	1997[3/]	1998[4/]
Milk (3)	143	30	29	63	–	34	32	95	–	1.05	1.09	1.37

Sources/Zdroj: [1/] OECD, 2001; [2/] Bojnec, 1999 and 2001; [3/] Kavcic, 1998; [4/] Kuhar, 1999

Tabuľka 3 Ukazovatele ochrany, transferov politík a medzinárodnej konkurencieschopnosti v Slovinsku
(1) ekvivalent produkčných subvencií (PSE v %), (2) roky, (3) mlieko, (4) miery nominálnej a efektívnej ochrany, (5) náklady na domáce zdroje

decline is a slightly faster in a case that current nominal Euro prices are deflated by the consumer price index for the Euro zone. The entry of Slovenia into the EU led to further milk price declines. However, according to most recent evidence, there has been an increase in cow's milk price in 2007 and 2008 both at the farm-gate and at the consumer levels caused by an inverse whether conditions and lack of competition in dairy processing and marketing chains. During these two years Slovenia has also replaced SIT by Euro.

In comparison with the EU prices, milk prices in Slovenia were initially less than in EU, and since 1998 they have been approaching or even slightly exceeding the EU levels (EU-Commission, 2002). It is worth mentioning that unlike in other Central and Eastern European transition countries, Slovenian agricultural and food prices in several cases were above the relevant EU levels during the second half of the 1990s.

The international competitiveness for cow milk in Slovenia is constraint by high production costs that are caused by less favourable natural conditions and relatively small-scale farm structures. Prior to the EU accession, domestic cow milk production was shield by the protection measures and government transfers. This is revealed by high nominal protection rates and even higher effective protection rates as well as by high producer subsidy equivalents (PSEs) (OECD, 2001 and Table 3). The significant share of value for milk producers was delivered via the government transfers. The product is competitive internationally when the DRC measure is between less than 1 and greater than zero. Unfavourable natural conditions, lower efficiency of small-size individual private farms, and high costs of domestic resources and non-tradable services are the most important constraints impeding competitiveness at international economic conditions.

The calculations of the GLIIT indexes revealed initial relatively low level of integration of Slovenian agricultural and food products in international trade (FAO, 1999; Bojnec and

Table 4 The share of domestic production in domestic consumption in % in Slovenia

	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Milk(1)	121	111	114	115	115	113	120	122	120	119	117	119	117

Sources: OECD (2001), and Agricultural Institute of Slovenia (2006)

Tabuľka 4 Podiel domácej produkcie v domácej spotrebe Slovinska v %
(1) mlieko

Table 5 Cow's milk production and its quality in Slovenia

	1995	2000	2001	2002	2003	2004	2005	2006
Number of cows and heifers in calf (1)	241 737	205 306	200 030	206 858	197 912	193 865	188 456	185 844
Number of milk cows at the end of the year (2)	147 608*	140 236	135 805	139 980	130 711	134 009	–	–
Yield in litres per cow (3)	3 681*	4 224	4 520	5 202	4 589	4 821	–	–
Net production of cow's milk – total (1 000 l) (4)	589 985	629 736	633 820	706 446	642 380	631 456	639 836	623 555
Cow's milk collected by dairies (1000 l) (5)	388 400	440 676	458 996	473 479	484 180	488 683	493 535	496 133
Quality of purchased milk (6):								
– average percent of fats (7)	3.93	4.10	4.12	4.13	4.14	4.16	4.15	4.08
– average percent of proteins (8)	3.24	3.36	3.34	3.33	3.34	3.36	3.36	3.31
– bacteriological class extra in % (9)	61.50	85.71	90.46	90.78	91.75	92.96	93.72	90.15
– bacteriological class 1 in % (10)	17.12	9.45	6.24	6.38	6.35	5.62	4.79	7.63

* 1997 data
Slovenian Dairy Association, Volk and Zagorc (2005) and SORS (2007)

Tabuľka 5 Produkcia kravského mlieka v Slovinsku a jeho kvalita
(1) počet kráv a teľných jalovíc, (2) počet mliekových kráv na konci roka, (3) výnos v litroch na kravu, (4) čistá produkcia kravského mlieka – celkovo (1 000 l), (5) kravské mlieko zhromaždené v mliekarňach, (6) kvalita vykúpeného mlieka, (7) priemerné percento tuku, (8) priemerné percento proteínov, (9) bakteriologická 'extra' trieda, (10) bakteriologická prvá trieda

Hartmann, 2004; Majkovič et al., 2007). There are, however, differences by product categories and by geographical markets. The GLIIT indexes with the former Yugoslav republics are among the highest in spite of trade disintegration and barriers, which have been imposed on trade. The GLIIT indexes for dairy products and eggs (SITC 02) are relatively low. The traditional former Yugoslav markets have remained the most important destination for the Slovenian exports of dairy products. As expected, the level of integration with the EU markets is increasing with trade liberalization and EU membership. As most of trade in dairy products with the EU is still inter-industry type, reallocation of factors and restructuring of dairy industry has occurred upon the EU accession. One-way trade flows in dairy products are even more often seen with the rest of the world. Liberalization of trade and the EU accession have caused an additional adjustments and restructurings in the Slovenian dairy sector.

Export-to-import price ratio of a similar product implies similarity and quality differences between exported and imported product. For dairy and eggs (SITC 02) the ratio increased from less than 1 (0.778 in 1992) to more than 1 (1.009 in 1995), and declined again at less than 1 (0.719 in 1999). With the EU-15, the ratio was low initially (less than 0.6 in 1992), but increased after then (1.175 in 1995), with the decline to less than 1 since 1996. Since 1995, Slovenia has exported to the EU-15 cheaper products than imported and thus the decline or stagnation in terms-of-trade has been identified with the EU-15 also later (Bojnec and Fertő, 2007a and 2007b). The ratio of export-to-import price for dairy does not reveal improvements in quality of exported vis-ŕ-vis imported similar products. This suggests that additional efforts are needed in order to further increase quality of exports and quality of production towards the increasing competitive pressures arising from trade liberalisation and adjustments on the business conditions in the SEM. However, the surplus in milk production in Slovenia has continued (Table 4). The largest surplus occurred in 1999. The milk surplus has largely been exported in the neighbouring Italy and Croatia as well as to other countries on the territory of the former Yugoslavia.

The number of cows and heifers in Slovenia has declined steadily during the last two decades. The decline is also recorded for the number of milk cows (Table 5). However, on the other hand, cow's milk production has increased up to the year 2002 clearly indicating the increase in the yield of milk per cow. The decline in cow's milk production and its stabilization after 2002 can be explained by adjustments of the Slovenian dairy sector on the membership in the EU and on stronger competition in the Single European Market (SEM). In spite to the fact that net cow's milk production in Slovenia has declined since 2002, the cow's milk collected by dairies has increased. This implies an ongoing process of the dairy farm restructuring by the exit of small farms that were not able to comply with an increased quality standards and requirements as well as not being anymore cost and price competitive. Clearly, there has been the rapid increase in the bacteriological class extra from 61.5 percent in 1995 to 85.7 percent in 2000 and further up to 93.7 percent in 2005. On the other hand, the bacteriological class 1 has been reduced rapidly from 17.1 percent in 1995 to 9.5 percent in 2000 and 4.8 percent in 2005. This indicates the significant increase in quality of purchased cow milk. The average milk fat for the cow milk delivered to dairies in Slovenia is around 4.1 percent and the average protein content is around 3.3 percent.

Although in Slovenia the dairy farm concentration and specialization is an ongoing process, milk production is still on different farm structures. The implementation of the CAP-15 in Slovenia has even resulted in farm and dairy farm de-concentration as both the total number of farms and dairy farms, respectively, have increased between the pre- and

Table 6 Milk quotas, direct payments and intervention prices for Slovenia, 2004–2007

	2004/05	2005/06	2006/07	2007/08
Milk quota (000 tones) (1)	560,424	560,424	576,638	576,638
Direct premium payments (Euro/tone) (2)	6.9 (8.15)	14.7 (16.31)	– (24.49)	– (24.49)
Envelope for additional payments (000 Euro) (3)	2,051	4,114	6,170	6,170
Additional payment (Euro/tone) considering envelope and quota for Slovenia (4)	3.7 (3.66)	7.3 (7.34)	– (10.70)	– (10.70)
Intervention price (Euro/tone) (5):				
– butter (6)	3,282.00	3,117.90	2,953.80	2,789.70
– skimmed milk in powder (7)	2,055.20	1,952.40	1,849.70	1,746.90

Note: In the parenthesis are full amount payments in the EU-15
Source/Zdroj: Volk and Zagorc, 2005

Tabuľka 6 Mliečne kvóty, priame platby a intervenčné ceny pre Slovinsko, 2004–2005
(1) mliečna kvóta, (2) priame prémiové platby, (3) finančná obálka pre dodatkové platby, (4) dodatkové platby s ohľadom na obálku a kvótu pre Slovinsko, (5) intervenčná cena, (6) maslo, (7) odtučnené mlieko v prášku

after-entry of Slovenia into the EU. Therefore, so far the entry of Slovenia into the EU has not resulted neither in farm decline nor in farm size increases. The major farm restructuring in Slovenia had been achieved before the entry of Slovenia into the EU and before full adjustment of the Slovenian agricultural policies to the CAP of the EU-15. With the entry of Slovenia into the EU, in the market year 2004/05, Slovenia has begun with the implementation of the CAP policies for milk by the introduction of the milk quota system, direct payments and intervention prices for the period 2004–2007 (Table 6). Since 2004/05, farmers in Slovenia have been eligible for direct payments (base premium and additional payments) with the quota system in an amount of around 10.60 Euro/tone. Whereas intervention price for butter and skimmed milk in powder have been gradually reduced, direct payments to farmers have increased.

The empirical results have confirmed an ongoing process of restructuring of cow milk production in Slovenia. Quality of cow milk has improved considerably since the EU quality standards have been implemented. The Slovenian agricultural and dairy sector policies have been adjusted to the CAP of the EU-15. Dairy production in Slovenia in the past has been protected, which caused the lower level of international competitiveness. Nominal and effective protection rates for dairy products have been relatively high, while international competitiveness measured by domestic resource costs indicated a lack of international competitiveness. With the introduction of comparable EU quality standards the purchased milk of higher quality has increased substantially. An increase is also recorded in the relatively low yield per cow, whereas cow milk production has been concentrated towards more efficient family farms. Some small producers, particularly during the pre-accession period, stopped with milk production. With the exit of traditional, smaller family milk producers, the commercialisation and concentration of cow milk farms have increased towards more productive and efficient larger family farms specialized in milk production. A shift in milk production from family household's subsistence needs towards greater commercialisation of farms have occurred and the share of marketed production outside the family households increased.

Therefore, similar to some other new member states of the EU, Slovenia has made substantial quality improvements in cow milk production. The ongoing process of market selection, concentration and rationalisation of production is an outcome of the increasing competitive pressures and the EU membership. With the Slovenian gradual adjustment of agricultural policy to the CAP of the EU-15, there is no considerable difference in the level of agricultural protection between Slovenia and the EU-15. Since 2004, agricultural policy and particularly budgetary measures in Slovenia have been applied to make agricultural policy comparable with the CAP of the EU-15, which has not be the case for other new member states of the EU. With the Slovenian membership in the EU, imports of dairy products have increased and some decline in exports of dairy products occurred. However, Slovenia has remained the net exporter of milk and dairy products, particularly for some niche products, but the Slovenian dairy sector is challenged by the foreign competitors to keep the market shares on domestic markets and to increase exports to the EU markets.

Súhrn

Príspevok analyzuje vývin trhu v oblasti slovinského mliekarstva so zameraním na reštrukturalizáciu, zlepšenie konkurencieschopnosti a kvality mlieka. Mliekarský trh a výroba v Slovinsku prešli zmenami, ktoré zabezpečili štrukturálne prispôsobenie a harmonizáciu s kvalitatívnymi štandardami v Európskej únii, implikovanými na domáci mliekarský trh. Slovinsko zostalo čistým exportérom mliečnych výrobkov. So zavedením kvalitatívnych štandardov, ktoré sú porovnateľné s Európskou úniou, za značne zvýšil pomer mliekarskej produkcie umiestnenej na trhu a kvalita vykupovaného mlieka. Zvýšila sa relatívne nízka dojivosť, keďže produkcia dojníc sa zamerala najmä na produktívnejšie rodinné farmy. Posun mliekarskej výroby od tej, ktorá zabezpečovala len rodinné potreby k produktívnejším a väčším rodinným farmám, špecializovaným na produkciu mlieka mal za následok vyššiu komercializáciu a koncentráciu fariem dojníc s prerozdelením existujúcich faktorov v jestvujúcom mliekarskom sektore.

Kľúčové slová: mliekarstvo, reštrukturalizácia, konkurencieschopnosť, zlepšenie kvality

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Acta oeconomica et informatica 2
Nitra, Slovaca Universitas Agriculturae Nitriae, 2008, s. 45–49

THE IMPACT OF FIXED ASSETS ON POLISH AGRICULTURAL PRODUCTION

VPLYV DLHODOBÉHO HMOTNÉHO MAJETKU NA POĽSKÚ POĽNOHOSPODÁRSKU PRODUKCIU

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The power function was used to show the dependence of gross, final and sold output on the gross value of total fixed assets and on the ratios of this value to the productivity of these three production categories. Further elaboration included the characteristics of variable features. The system of independent variables employed in the study allowed for the estimation of both extensive and intensive utilisation of fixed assets in Polish agriculture from 2002–2005. The study showed the diminishing impact of the productivity of fixed assets and the decreasing productive efficiency of Polish agriculture from 2002–2005. This situation was caused by the relative stability in the generic structure of fixed assets and by a slow average annual rate of increase in new fixed assets (8.74 %).

Key words: production, productivity, impact, extensive and intensive utilisation of fixed assets

This paper examines the potential of fixed assets on Polish agriculture during the period 2002–2005. Poland's accession to the EU (Lissitsa and Balmann, 2003) in May 2004 induced several changes in Polish agricultural development. This study reveals the extent of these changes on the utilisation of fixed assets in agricultural production.

The potential of fixed assets includes information on their quantitative and qualitative impact as well as their utilisation. This makes it possible to use a conventional system of interpretation to explain changes in the quantitative and qualitative impact of fixed assets in determining the comparative levels of gross, final and sold output in Polish agriculture from 2002–2005.

Material and methods

The power function was the basic method of deriving the functional model[1/] showing the dependence of gross, final

[1/] Verification of the lowest squares assumptions method was conducted basing on the rests being estimations of random components in econometric model. The survey of random deviations attributes was conducted using tests. Random surveying-test of numbers series. Normality survey-test of Shapiro-Wilk. Auto-correlation survey-test of Durbin-Watson. Survey of homoscedastity-test Goldfeld-Quandt.

Table 1 Statistical characteristics of the variables under study in Polish agriculture from 2002–2005 (2002 prices)

Symbol (1)	Units (2)	Arithmetic mean (3)	Range (4)		Variation coefficient in % (5)
			min	max	
2002					
Y1	zl	3,481,625,000	1,106,302,135	8,574,057,420	61.57
Y2	zl	2,531,062,500	802,160,910	6,406,243,717	64.19
Y3	zl	2,171,206,250	704,927,270	5,440,659,976	63.90
X1	zl	6,904,968,750	2,293,274,445	14,459,864,729	47.46
X2	zl/zl	0.485	0.364	0.648	17.57
X3	zl/zl	0.351	0.241	0.476	19.53
X4	zl/zl	0.301	0.200	0.404	19.68
2003					
Y1	zl	3,453,772,000	938,090,582	8,300,424,467	62.08
Y2	zl	2,594,339,063	719,448,152	6,412,939,814	64.75
Y3	zl	2,284,108,975	680,013,472	5,884,011,509	64.95
X1	zl	6,822,109,125	2,274,689,794	14,423,867,848	48.01
X2	zl/zl	0.484	0.365	0.621	17.18
X3	zl/zl	0.362	0.251	0.480	18.52
X4	zl/zl	0.319	0.204	0.440	18.98
2004					
Y1	zl	3,712,804,919	1,316,605,280	9,122,675,512	60.09
Y2	zl	2,801,886,188	1,038,485,707	7,043,273,821	62.77
Y3	zl	2,359,362,366	833,624,865	5,988,260,625	63.86
X1	zl	6,787,998,228	2,295,543,011	14,332,925,458	47.84
X2	zl/zl	0.531	0.395	0.686	15.92
X3	zl/zl	0.400	0.260	0.529	18.08
X4	zl/zl	0.335	0.198	0.450	19.67
2005					
Y1	zl	3,556,867,094	1,264,788,878	10,009,618,667	66.67
Y2	zl	2,681,459,133	942,409,907	7,846,616,135	71.37
Y3	zl	2,260,386,219	810,895,724	6,735,017,060	71.59
X1	zl	6,787,998,579	2,213,233,586	15,832,104,345	53.41
X2	zl/zl	0.511	0.374	0.770	19.46
X3	zl/zl	0.380	0.250	0.604	22.01
X4	zl/zl	0.323	0.190	0.518	24.79

Y1 – value of gross production, Y2 – value of final production, Y3 – value of sold production, X1 – gross value of total fixed assets, X2 – ratio of the productivity of total fixed assets to gross production, X3 – ratio of the productivity of total fixed assets to final production, X4 – ratio of the productivity of total fixed assets to sold production
Y1 – hodnota hrubej produkcie, Y2 – hodnota finálnej produkcie, Y3 – hodnota predanej produkcie, X1 – hrubá hodnota celkového dlhodobého hmotného majetku – CDHM, X2 – pomer produktivity CDHM k hrubej produkcii, X3 – pomer produktivity CDHM k finálnej produkcii, X4 – pomer produktivity CDHM k predanej produkcii
Source: Central Statistical Office in Warsaw. The calculations are the researchers' own
Zdroj: Centrálny štatistický úrad vo Varšave, autorove vlastné výpočty

Tabuľka 1 Štatistické charakteristiky premenných skúmaných v poľskom poľnohospodárstve v rokoch 2002–2005
(1) symbol, (2) jednotky, (3) aritmetický priemer, (4) rozsah, (5) variačný koeficient

and sold output on the gross value of fixed assets and the ratios of this value to the productivity of these three production categories in agriculture during the period 2002–2005. Some descriptive statistical measures were also used to describe variable features as required.

Empirical data were taken from the statistical yearbooks of the Central Statistical Office and the regional Statistical Yearbooks of the Central Statistical Office for the period under investigation. These latter include numerical data from the Central Bureau of the Polish Hunting Union in Warsaw.[2/] Data are expressed in 2002 prices.

[2/] Percentage share of fixed assets gross values in hunting within 1995–2003 hesitated from 0.01–0.04 %. Annex to the letter dated on 8. 10. 2005 from The Central Bureau of Polish Hunting Union in Warsaw. It shows that their share in fixed assets gross value totally for agriculture had no impact on shaping surveyed economic occurrences.

Table 2 The dependence of gross, final and sold production (Y1, Y2 and Y3) on the gross value of total fixed assets in Polish agriculture from 2002–2005

Year (1)	Regression coefficient (2)		Standard error (3)		Test t (4)		R^2
	A	X1	A	X1	A	X1	
Gross Production (5)							
2002	0.0146	1.1548	2.0799	0.0922	-2.03	12.53	0.92
2003	0.0049	1.2034	1.9102	0.0845	-2.78	14.21	0.94
2004	0.0179	1.1056	2.0231	0.0897	-2.05	12.32	0.92
2005	0.0282	1.0569	2.0254	0.0979	-2.09	10.79	0.90
Final Production (6)							
2002	0.0080	1.1692	2.3386	0.1037	-2.06	11.25	0.90
2003	0.0029	1.2129	2.0755	0.0920	-2.81	13.18	0.93
2004	0.0144	1.1023	2.3880	0.1059	-2.04	10.41	0.89
2005	0.0293	1.0907	2.4793	0.1101	-2.01	9.99	0.88
Sold Production (7)							
2002	0.0065	1.1691	2.4158	0.1071	-2.08	10.92	0.90
2003	0.0037	1.1968	2.2347	0.0991	-2.50	12.08	0.91
2004	0.0079	1.1341	2.4222	0.1163	-2.06	9.75	0.87
2005	0.0103	1.0629	2.2673	0.1317	-2.48	8.07	0.83

significance level < 0.05; a – absolute value (without logarithm; other determinations as per Table 1
úroveň signifikancie < 0,05; a – absolútna hodnota (bez algoritmu); ostatné ako v Tabuľke 1
Source: arithmetic calculations Zdroj: aritmetické výpočty

Tabuľka 2 Závislosť hrubej, finálnej a predanej produkcie (Y1, Y2, Y3) od hrubej hodnoty celkového dlhodobého hmotného majetku v poľskom poľnohospodárstve v rokoch 2002–2005
(1) rok, (2) regresný koeficient, (3) štandardná odchýlka, (4) T test, (5) hrubá produkcia, (6) finálna produkcia, (7) predaná produkcia

The examined variables are characterised by arithmetic mean, range and variation coefficient. These are presented in Table 1.

Table 1 shows that despite the decrease in the range and average value of variables related to sold production, its variability has been increasing in recent years. The growth of dispersion within variables was not high enough to alter their role significantly during the period under investigation. Material differences in dispersion were only observed between quantitative variables and quantitative variables with qualitative features.

Research ssues

The study attempted to show how changes in the quantitative and qualitative impact of total fixed assets determined the variability in gross, final and sold production in Polish agriculture from 2002–2005. The study simultaneously attempted to identify that portion of production obtained through the quantitative (extensive) and qualitative (intensive) utilisation of fixed assets in agriculture. Later synthesis of these research issues made it possible to assess the use of fixed assets in agriculture and indicated the directions in which they are developing. The results are presented more accurately in the Conclusions section. The conventional system of interpreting the role of fixed assets in agriculture was the basis on which these research goals were established.

Presentation

Table 2 illustrates the functional dependence of gross, final and sold production on the gross value of total fixed assets.

The data from Table 2 show that the gross value of total fixed assets explains 83–94 % of the variation in the production categories under investigation. The significance level of 0.00–0.05 was very high. On the other hand the standard errors in the regression coefficients were less than 50 % of their absolute values and the test t values exceeded their critical levels. Fixed assets regression coefficients increased for each of the production categories under investigation during 2002 and 2003 but decreased during 2004 and 2005. However, gross, final and sold production all increased more rapidly than fixed assets between 2002 and 2005. The absolute values (a) of overall production efficiency exhibited a slight increase (Vizvari and Bacsi, 2002). This implies that the application of the gross value of fixed assets was relatively low in Polish agriculture over the period under study (Zwolak, 2001).

Table 3 illustrates the dependence of gross, final and sold production on the overall productivity of fixed assets for each of these three production categories.

The data from Table 3 show that the degree to which the variation in the examined variables could be explained was a relatively low 0.00–0.05. The Standard errors in the regression coefficients were less than 50 % of their absolute values and the test t values exceeded their critical levels. Fixed assets productivity regression coefficients increased for each of the production categories under investigation during 2002 and 2003 but decreased in 2004 and 2005 (Oehmke, 2004) This mirrors the changes in the fixed assets regression coefficients between 2002–2005 (refer Table 2). Comparing the fixed assets productivity regression coefficients reveals that both fixed assets and the production categories under investigation were increasing more rapidly than fixed assets productivity from 2002–2005. The changes in the fixed assets productivity regression coefficients correlated to the changes in production efficiency for the period under investigation (Carlaw and Lipscy, 2003). This decreasing elasticity in the production categories under investigation relative to the productivity of fixed assets

Table 3 Dependence of gross, final and sold production (Y1, Y2 and Y3) on overall productivity of fixed assets for each production category in Polish agriculture from 2002–2005

Year (1)	Regression coefficient (2)		Standard error (3)		Test t (4)		R^2
	A	X2, X3 and X4	A	X2, X3 and X4	A	X2, X3 and X4	
Gross Production (5)							
2002	13,916,823,782	2.0828	0.4876	0.6449	47.90	3.23	0.43
2003	17,830,817,591	2.4339	0.4526	0.5973	52.15	4.07	0.54
2004	10,665,226,947	1.8524	0.4806	0.7243	48.04	2.56	0.30
2005	8,019,361,643	1.4138	0.5064	0.7124	45.04	1.98	0.30
Final Production (6)							
2002	16,969,851,338	1.9393	0.6283	0.5814	37.49	3.33	0.44
2003	23,627,660,866	2.2988	0.5884	0.5614	40.59	4.09	0.54
2004	10,883,943,368	1.6108	0.6011	0.6322	36.44	2.55	0.32
2005	9,984,547,778	1.5101	0.6241	0.6189	36.89	2.44	0.30
Sold Production (7)							
2002	18,621,712,832	1.8941	0.6989	0.5662	33.85	3.35	0.44
2003	22,552,549,684	2.1166	0.6605	0.5624	36.09	3.76	0.51
2004	12,646,601,421	1.6465	0.6350	0.5609	36.63	2.93	0.38
2005	8106845399	1.2549	0.6317	0.5335	36.12	2.35	0.30

significance level < 0.05; a – absolute value (without logarithm; other determinations as per Table 1
úroveň signifikancie < 0,05; a – absolútna hodnota (bez algoritmu); ostatné ako v Tabuľke 1
Source: arithmetic calculations Zdroj: aritmetické výpočty

Tabuľka 3 Závislosť hrubej, finálnej a predanej produkcie (Y1, Y2, Y3) od celkovej produktivity celkového dlhodobého hmotného majetku pre každú kategóriu produkcie v poľskom poľnohospodárstve v rokoch 2002–2005
(1) rok, (2) regresný koeficient, (3) štandardná odchýlka, (4) t test, (5) hrubá produkcia, (6) finálna produkcia, (7) predaná produkcia

Table 4 The impact of the gross value of total fixed assets and the ratios of their productivity to gross, final and sold production on the relative growth in production for these three categories in Polish agriculture in the years 2002–2005 in %

Years (1)	Gross (2)		Final (3)		Sold (3)	
	X1	X2	X1	X3	X1	X4
2002	35.67	64.33	37.61	62.39	38.17	61.83
2003	33.08	66.92	34.54	65.46	36.12	63.88
2004	37.38	62.62	40.63	59.37	40.79	59.21
2005	42.78	57.22	41.94	58.06	45.86	54.14

Source: derived from Tables 2 and 3. The calculations are the researchers' own
Zdroj: odvodené z tabuliek 2 a 3. Výpočty autora

Tabuľka 4 Dopad hrubej hodnoty dlhodobého hmotného majetku a pomeru jeho produktivity k hrubej, finálnej a predanej produkcii na relatívny rast produkcie pre tieto tri kategórie v poľskom poľnohospodárstve v rokoch 2002–2005 v %
(1) hrubá, (2) finálna, (3) predaná

explains the decrease in production efficiency independently of the production category for the period under investigation. Table 4 illustrates the synthesis of the research.

The data from Table 4 show that refining gross production in the direction of sold production brought about a growth in the quantitative share (extensive) of fixed assets utilised in agriculture. Similar types of changes took place during the period under investigation. The extensive utilisation of fixed assets was increasing while their intensive utilisation was decreasing. The relatively stable structure of fixed assets can explain this[3/] as their gross value decreased by only about 1.69 % between 2002 and 2004 and remained constant in 2004 and 2005 (2002 prices) (Zwolak, 2005). But their amortisation between 2002 and 2005 rose 2.1 percentage points while the average annual rate of increase in new fixed assets was 8.74 %.[4/] This is three times lower than "normal" in agriculture. This inevitably led to a loss of both features and functions in fixed assets which in turn brought about a decrease in their intensive utilisation in Polish agriculture.

Conclusions

The foregoing enables the following conclusions to be drawn.

1. The gross value of total fixed assets explained 83–94 % of the variation in gross, final and sold production in Polish agriculture from 2002–2005. But the overall productivity of fixed assets only explained 30–54 % of the variation in these three categories of production. This was reflected in

[3/] Fixed assets structure in 2002, 2003, 2004 and 2005 amounted like follows; farm buildings 61%, machines technical equipment and tools 13%, transport means 12% and other fixed assets 14%.

[4/] Regarding prices from 2002 one counted the share of new fixed assets values in total fixed assets in surveyed years, and next the dynamics towards previous year and estimated their average annual growth rate. Source; Statistical Yearbook of Central Statistical Office-respective years.

the greater dispersion within the gross values of fixed assets than their productivity in agriculture for the period under investigation.

2. Decreases in the impact of fixed assets productivity were found to correspond with decreasing productive efficiency in Polish agriculture from 2002–2005. This can be explained by the stability in the state and generic structure of fixed assets in 2004 and 2005. These were partially replaced by new fixed assets. The rate of increase in new fixed assets within this stable situation was three times lower than "normal" (8.74 %).
3. Taking 50 % as a basis for elementary intensive and extensive utilisation of fixed assets, it has to be said that the utilisation of intensive fixed assets was only about 10 percentage points higher and was decreasing over time. This was a result of the inability to intensively engage fixed assets in Polish agricultural production. This makes the need to accelerate the renewal of fixed assets in Polish agriculture all the more urgent.

Súhrn

Na preukázanie závislosti hrubej, finálnej a predanej produkcie od hrubej hodnoty celkového dlhodobého hmotného majetku a vzťahov tejto hodnoty k produktivite týchto troch výrobných kategórií bola použitá mocninová funkcia. Ďalej boli podrobne spracované charakteristiky vlastností premenných. Systém nezávislých premenných použitých v práci umožnil odhad aj extenzívneho aj intenzívneho využitia dlhodobého hmotného majetku v poľskom poľnohospodárstve v období 2002–2005. Táto situácia bola zapríčinená relatívnou stabilitou generickej štruktúry dlhodobého hmotného majetku a pomalou ročnou mierou rastu nového dlhodobého majetku (8,74 %).

Kľúčové slová: produkcia, produktivita, dopad, extenzívne a intenzívne využitie dlhodobého hmotného majetku

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Acta oeconomica et informatica 2
Nitra, Slovaca Universitas Agriculturae Nitriae, 2008, s. 50–55

AN ASSESSMENT OF THE AGRICULTURAL ENTERPRISES' SOLVENCY WITH THE USAGE OF THE ALTMAN MODEL

HODNOTENIE PLATOBNEJ SCHOPNOSTI POĽNOHOSPODÁRSKYCH PODNIKOV PODĽA ALTMANOVHO MODELU

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The paper deals with the analysis of the relationship between the Z index in Altman model and selected features which characterize agricultural enterprises e.g.: land ownership, cropland area, assets and ownership capital value, profitability, liquidity and debt turnover. In order to provide the presented research a number of 118–123 big agricultural enterprises was surveyed in years 2000–2004. It was stated that the economic forecast of solvency level of agricultural enterprises is relatively difficult. The APA companies have been characterized by the highest degree of Z index, while in enterprises of leaseholders and owners the said indicator was placed on rather lower level of the ambiguous classification. In enterprises with the smallest area of cropland, this indicator was the highest. Together with a profitability growth of land use, the indicator Z has been increased relatively. This kind of relationship has not been found in the case of ownership capital profitability. The lack of current liabilities in enterprises did not determine their solvency explicitly. The enterprises with the highest level of current liquidity were characterized by the highest Z indicator, and generally they were in the area of solvency. The relationships between the debt turnover indicator and agricultural enterprises' solvency were not confirmed explicitly.

Key words: Altaman Z index, assets and ownership capital, profitability, liquidity, debt turnover

The assessment of the enterprises' financial situation is a process of arriving financial decisions, which concern gaining the capital, introducing the investments and setting the directions of financial investment allocations, in order to maximize enterprise value (Czekaj and Dresler, 1995). Methods of estimating financial situation of enterprises are diverse, from classical indicators in static and dynamic point of view to more advanced statistic methods. The discriminatory models belong to these methods. They are used to predict financial problems, e.g. the bankruptcy of enterprises and risk of credit rating loss. The discriminatory models belong to the class of the synthetic indicators systems. In last years many models, which enable to forecast the enterprise bankruptcy, were devised in western countries. Models that are presented in the literature, aside from, which quantitative methods were generally used to their construction, are based on the information about enterprise condition, provided by financial indicators.

The first method used to build multidimensional model forecasting insolvency was the discriminatory analysis, which to these days is found the most popular. The discriminatory analysis allows aggregating into one value, the information provided by many indicators, which characterize the current financial situation of the enterprise. The empirical research showed the considerable rightness of the prediction obtained on the grounds of discriminatory function.

The well-known creator of discriminatory analysis fundamentals W.H. Beaver began the trend of assessing enterprises condition in order to predict possible bankruptcy. The comprehensive index analysis, of both enterprises with good financial situation, as well as enterprises, which went to default, enabled to formulate conclusions, which have had the key meaning for all subsequent researches over the insolvency and its prediction. On the basis of dynamic indicator analysis it was stated that only few of financial indexes allow forecasting a default, because their construction enables to indicate problems of enterprises even few years before their appearance (Hadasik, 1998). The other idea is the multidimensional model of K. Beerman, who undertook the attempt of the discriminatory function introduction for each previous year before the bankruptcy occurrence. It uses constantly the same financial indicators as the series of variables. These values depending on the forecasting period have assigned different variables, what diversify the estimation of the financial default level.

The application of the discriminatory analysis to the prognosis of the enterprises bankruptcy is connected to the first works of E.I. Altman, who first leant the model construction on lineal discriminatory function.[1/] This model has established one fixed value of Z index, below which the enterprise was threatened with the insolvency. The area of the uncertainty and the safety value were also marked, and exceeding the uncertainty level means in general the unimpeded development of the enterprise. According to this idea of discriminatory functions and on the ground of empirical research there has been accepted the critical point of the Z index value, which enables to generate in principle two groups of examined units: those threatened with the bankruptcy and those being in a relatively good financial situation.

The models which predict the bankruptcy and take into account the specificity of the Polish economy, are these proposed by: J. Gajdka i D. Stos, D. Hadasik, A. Hołda, M. Pogodzińska i S. Sojak, E. Mączyńska oraz D. Wierzba (Siemińska, 2002). One of the most well-known and first erected models, which is based on data of enterprises run in Poland, is the model of J. Gajdka and D. Stos. This model has been created with the usage of the lineal multidimensional technique of the discriminatory analysis. From

[1/] The original form of the Altman's model from year 1968 is following (Altman, 1968).

among 20 selected indicators, five were classified into the main model (Hamrol, 2005). In Hołda's model 40 polish enterprises which went bankrupt and 40 of those which continued their activity on the market were analysed. Enterprises became chosen due to their line of business, on the basis of the NACE – Statistical Classification of Economic Activities in the European Community (Prusak, 2005). The received multidimensional discriminatory function divided enterprises into two groups: threatened and not threatened with the bankruptcy (Zaleska, 2002). This model similarly to Altman's has its middle sphere. Presented models were the first signs of this kind of analysis in polish conditions and in the assessment area of the financial situation in enterprises on the stock exchange.

Material and methods

The aim of the elaboration is to qualify the relationships between the value of Z index in the Altman model and chosen variables characterizing the activity of agricultural enterprises. The applied criteria, used to categorise the enterprises, will allow for synthetic estimation of the said group according to the chosen feature.

The investigative period involves years 2000–2004. Researches were conducted in companies of Agricultural Property Agency (APA), enterprises with the lease of the ground from APA and enterprises, in which the land purchase from APA companies appeared.[2/] The selection of research objects was intentional, and their managers agreed to impart the information.[3/] The calculation of indicators was made according to variables in current prices. Analysed enterprises are situated on the whole area of Poland and include all provinces. The influence on results of the analysis connected with changes of the number of enterprises in individual legal forms was minimal, and authors' intention was to involve the greatest possible number of them in the research.

The application of a discriminatory analysis for research sector required different estimation of discriminatory function parameters. Altman revised the initial version of the Z function and offered in 1983 its modification with the usage of the same variables with one exception of X_4 variable, in which instead of the market ownership capital value, the balanced value (book value) was adopted. Repeated estimation of variables values and their following assignment did not cause further changes in the construction of particular indicators. This led to the creation of new form of model for those enterprises, which have not been listed on the stock exchange. The new version of the model called Z' function model has the following form (Siemińska, 2002):

$$Z' = 0.717X_1 + 0.847X_2 + 3.107X_3 + 0.420X_4 + 0.998X_5$$

This version of the model has been approved to the calculations and analysis, and it will be called hereinafter as „Z index." For this above version of model, the following brackets of the enterprises classification are obligatory:

- Z' < 1.23 – the zone of insolvent enterprises,
- 1.23 < Z' < 2.90 – the zone of ambiguous classification,
- Z' > 2.90 – the zone of solvent enterprises.

By defined in such way the discriminatory function and adopted threshold quantities, the margin of error in prediction was defined on the level of 6% (Zaleska, 2002). The remaining Altman models being more versatile, had a multi-sectorial character.

The chosen model is characterized both by the rightness of the prognosis and simultaneous evaluation of all essential areas in enterprise activity, including the elimination of the contradictory information resulting from them. The sectorial area of usefulness of this model persuaded authors to analyse this group of agricultural enterprises on the base of its principles. Indications of discriminatory analysis models allow for suitably quick detection of enterprises, which are or in the nearest time will be threatened with the bankruptcy. Constant analysis of value changes in the discriminatory function in successive years enables countermeasures against bad financial condition of the enterprise in future (Sabuhoro and Sobolewski, 2006). However, enterprises, which were classified into the zone of the uncertainty, demand careful inference. In the elaboration, it has been assumed that higher Z index in this zone, the probability of the enterprise bankruptcy is higher.

In order to make the division of the agricultural enterprises, the method of quartiles representing the value of research features according to the established community classification was used. The columns with defined quartiles were arranged according to growing value of the agreed classification criterion, which allowed the separation of four groups of enterprises.[4/] The first quartile involved enterprises with the lowest quantity of the given feature, the second quartile of the average quantity, the third quartile – higher than average, and the fourth the highest.

Agricultural enterprises were classified due to the criterion of the following quantitative features: the legal forms of farming, cropland area, real property value (thousand zl/hectare), the participation of the equity capital in liabilities in general (%), the profitability of land (thousand zl/ha of cropland), equity capital profitability (%),[5/] the level of current liquidity and the indicator of debt turnover. In the last two criteria of the agricultural enterprises classification the fifth group was separated, i.e. those enterprises, which did not possess liabilities (classification according to the current liquidity) and debts (classify according to the indicator of debt turnover).

Results

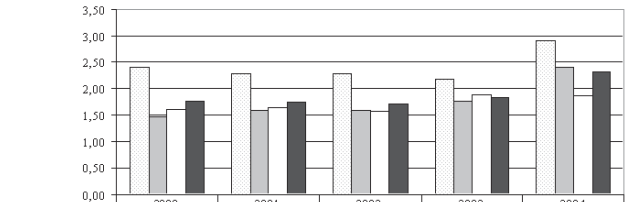
In the Figure 1, the formation of Z index in agricultural enterprises depending on the legal form of farming the land has been introduced. On average in the case of subjected

2/ The research became embracing enterprises which co-operate with the Institute of the Agriculture Economics and the Food-Economy – the National Research Institute in Warsaw.

3/ To the estimation were subjected 123 enterprises in years: 2000, 2001 and 2003; 122 enterprises in year 2002 and 118 in the year 2004.

4/ The number of agricultural enterprises groups were separated in the partition on quartiles in years 2000–2004 amounted properly: group I – 31, 31, 31, 31, 29; group II – 31, 31, 31, 31, 29; group III – 31, 31, 30, 31, 30; group IV – 30, 30, 30, 30, 30. The objects partition was made according to the criterion of the current liquidity ratio and was connected with the creation of group V with enterprises which did possesses any liabilities. The number of this group in years 2000–2004 amounted properly: 9, 6, 13, 12, 11. The classification according to the criterion of the debt turnover indictor also separated the group V of agricultural enterprises which did possesses any receivables. The number of this group in years 2000–2004 was shaped as follows: 31, 31, 29, 35, 10.

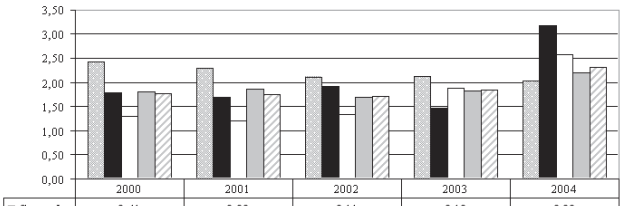
5/ During the classification of enterprises according to the criterion of the capital yield from research were switched off enterprises which posses the both negative equity capital, as well as they noted in the given year the loss. In years 2000–2004 were excluded the following number of enterprises: 5, 7, 8, 7, 1. After the exclusion once again enterprises were selected according to quartiles whose number in years 2000–2004 is following: group I: 30, 29, 29, 29, 29; group II: 29, 29; 28, 29, 29; group III: 29, 29, 28, 29, 29; group IV: 30, 29,29,29, 30.



	2000	2001	2002	2003	2004
APA companies	2,40	2,30	2,27	2,18	2,90
Lessees	1,47	1,59	1,59	1,76	2,40
Owners	1,60	1,66	1,58	1,87	1,86
Average	1,76	1,75	1,70	1,84	2,32

Figure 1 The prognosis of the agricultural enterprises bankruptcy depending on the legal form of the farm land implements[6/]
Source: Own elaboration

Obrázok 1 Prognóza bankrotu poľnohospodárskych podnikov v závislosti od právnej formy vlastníctva ich pôdy
Zdroj: Vlastné výpočty
(1) Spoločnosti agentúry pôdohospodárskeho vlastníctva (APA), (2) nájom, (3) vlastníci, (4) priemerne



	2000	2001	2002	2003	2004
Group I	2,41	2,28	2,11	2,13	2,03
Group II	1,79	1,69	1,92	1,48	3,18
Group III	1,31	1,19	1,34	1,87	2,56
Group IV	1,82	1,86	1,69	1,83	2,19
Average	1,76	1,75	1,70	1,84	2,32

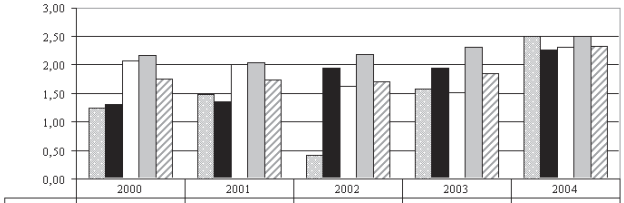
Figure 2 The prognosis of the agricultural enterprises bankruptcy depending on area of cropland in hectare
Source: Own elaboration

Obrázok 2 Prognóza bankrotu poľnohospodárskych podnikov v závislosti od ich hektárovej výmery v ha
Zdroj: Vlastné výpočty
(1) skupina I, (2) skupina II, (3) skupina III, (4) skupina IV, (5) priemer

enterprises, the said index was situated in the area of ambiguous classification, in most of years it was in its lower boarder. This reflects the complexity of agricultural enterprises activity, which depends on the natural conditions and market restrictions (the complex system of the market intervention). The growing tendency of Z index in years 2002–2004 (to 2.32) demands emphasis. In all examined years the highest indicator referred to APA companies, which in its initial fall of index quantity in the area of ambiguous classification in year 2000–2003, next year increased to 2.90. Therefore it can be stated that these companies were found in the area of solvent enterprises. In the remaining groups of enterprises, this indicator was situated in lower quantities of the area of ambiguous classification. In the most of examined years, Z index in owners' enterprises was imperceptibly higher in relation to enterprises of leaseholders. However, it is worth to underline that the tendency of indicator to increase in analysed group of enterprises, with relatively high level in 2004 (2.4) was homogenous. To sum up, it could be ascertained that within the framework of the area of ambiguous classification the quantity of Z index in selected groups of agricultural enterprises was relatively diverse.

The land is a basic factor of the production in agricultural enterprises that is why defining the prognosis of their bankruptcy depending on the said production factor seems to be interesting. Generally, it could be stated that enterprises from all selected groups of land have Z index in the area of ambiguous classification (except from the third group of enterprises in 2001) (Fig. 2). Besides year 2004, the domination of the level of Z index in enterprises with the smallest area of cropland was visible, with decline tendency in investigated years. The most profitable amount of index in these enterprises results from the fact of the possibility of rational saturation of cropland resources by means of production because of small changes of its land area. The situation of decreasing effectiveness of the successive cropland unit due to the increase of the land area does not appear here. Whereas this relationship could have appeared in enterprises with cropland area over the average (the third group), because in general the lowest quantity of analysed index referred to the group of enterprises which in 2001 was in the zone of insolvency. However, synonymous relations between the group of enterprises with the greatest cropland area and enterprises from the second group (with the average cropland area) did not develop. In farms from the fourth group of enterprises, the adjustment of production efficiency in relation to possessed resources of cropland has already appeared. The highest amount of Z index were yet noted down in the enterprises from the second group in year 2004 (3.18) and it was the only situation in this examined period when these enterprises were in the solvency zone.

In the Fig. 3 the amount of Z index depending on assets value in relation to cropland area has been presented. In the group of enterprises with the highest value of assets, the highest level of Z index was found. A very profitable effect was the growing tendency of index quantity in these enterprises in years 2001–2004 – up to the level of 2.51. This confirms the importance of the assets in improving the degree of the financial liquidity – and by this, the level of the solvency in a considerable manner. In the case of remaining groups of enterprises, no essential relations have been found. Only enterprises from the first group, with the lowest assets value, in 2002 were situated in the zone of insolvency (Z index was on the level of 0.43). In this group of enterprises the quantity of this indicator was the lowest also in year 2000 (1.25). It means that within lower level of assets value there is no fundamental diversity in the development of Z index. Whereas relatively close quantities of analyzed indicator in selected groups were



	2000	2001	2002	2003	2004
Group I	1,25	1,48	0,43	1,58	2,51
Group II	1,30	1,35	1,94	1,95	2,26
Group III	2,08	2,02	1,63	1,51	2,31
Group IV	2,17	2,04	2,19	2,30	2,51
Average	1,76	1,75	1,70	1,84	2,32

Figure 3 The prognosis of the agricultural enterprises bankruptcy depending on real property value in relation to area of cropland in thousands zł/hectare
Source: Own elaboration

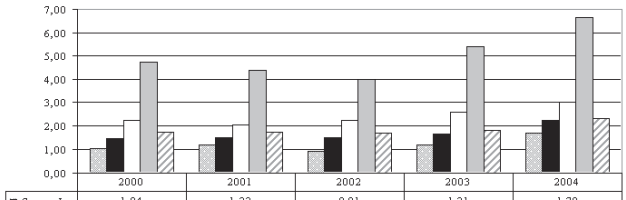
Obrázok 3 Prognóza bankrotu poľnohospodárskych podnikov v závislosti od skutočnej hodnoty pozemkov vo vzťahu k ich veľkosti v tis. zlotých/ha
Zdroj: Vlastné výpočty
(1) skupina I, (2) skupina II, (3) skupina III, (4) skupina IV, (5) priemer

6/ For the purpose of easier description, in the elaboration were accepted following signatures for each groups of enterprises: companies of Agricultural Property Agency – „APA companies", enterprises with the lease of the ground from APA – „Lessees", the enterprise which the land purchase from APA– „Owners".

noted down in year 2004. It shows diverse relationship between Z index and the level of assets value in particular years. The fact that agricultural production is characterized by relatively high level of dependence on price and natural conditions should also be taken into consideration. Therefore, the amount of Z index in relation to chosen production factors in the following years could reveal ambiguous relationships.

Because of considerable risk of the agricultural production the equity capital in general is predominant financing source of the agricultural enterprises activity and simultaneously it marks substantially their solvency. A confirmation of these relations is lower level of Z index in the group of enterprises with the lowest participation of equity capital in financing sources (Fig. 4). This group of enterprises was distinguished by big threat of insolvency in years 2000–2003. Only in year 2004, these enterprises could be qualified for the area of ambiguous classification in the range of potential bankruptcy. As far as Z index is below 1.23 in one or next year it still does not have to reflect a big threat, then the stated period of such situation in the first group of enterprises is dangerous in the scope of further functioning. However, agricultural enterprises with the highest equity capital were characterized by absolutely the highest amount of Z index which hesitated from 3.98 in 2002 to 6.62 in year 2004. It means that this group was located in the zone of solvent enterprises. The remaining groups of enterprises selected according to criterion of the participation of equity capital in financing sources were distinguished by considerably lower Z index, and the second and third group were assigned to the area of ambiguous classification of enterprises in terms of the bankruptcy prognosis (except the third group in year 2004). In all researched years, the growth of Z index together with the increase of the participation of the equity capital level in the structure of financing the activity of the enterprises has been reported. The highest difference in this regard between the first and fourth group of enterprises was ascertained in year 2004 (over 4.92). To summarise, it could be stated that the equity capital diversifies the level of Z index in substantial. This makes the formation of suitable relations between the equity and foreign capital by managers of a great importance.

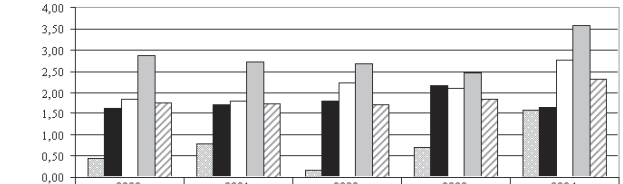
Generating the profit by enterprise is one of the fundamental circumstances of its functioning. However, in the last term, the depreciation of the importance of profit category as the final effect in enterprises' activity was noticeable. This



	2000	2001	2002	2003	2004
Group I	1,04	1,23	0,91	1,21	1,70
Group II	1,45	1,52	1,49	1,64	2,28
Group III	2,22	2,06	2,22	2,59	3,01
Group IV	4,72	4,40	3,98	5,38	6,62
Average	1,76	1,75	1,70	1,84	2,32

Figure 4 The prognosis of the agricultural enterprises bankruptcy depending on participation of the equity capital in financing resources in %
Source: Own elaboration

Obrázok 4 Prognóza bankrotu poľnohospodárskych podnikov v závislosti od podielu kmeňového kapitálu v ich finančných zdrojoch v %
Zdroj: Vlastné výpočty
(1) skupina I, (2) skupina II, (3) skupina III, (4) skupina IV, (5) priemer



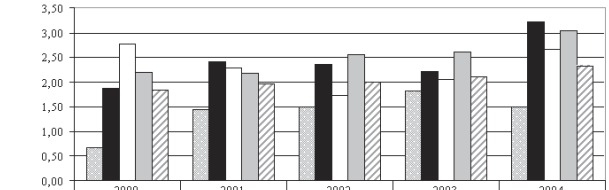
	2000	2001	2002	2003	2004
Group I	0,45	0,80	0,16	0,70	1,58
Group II	1,61	1,69	1,80	2,17	1,64
Group III	1,83	1,81	2,22	2,09	2,77
Group IV	2,87	2,72	2,69	2,46	3,57
Average	1,76	1,75	1,70	1,84	2,32

Figure 5 The prognosis of the agricultural enterprises bankruptcy depending on net profit in relation to area of cropland in thousands zł/hectare
Source: Own elaboration

Obrázok 5 Prognóza bankrotu poľnohospodárskych podnikov v závislosti od čistého zisku v vzťahu k rozlohe pôdy v tis. Zlotých/ha
Zdroj: Vlastné výpočty
(1) skupina I, (2) skupina II, (3) skupina III, (4) skupina IV, (5) priemer

arises from the fact of calculating this result category according to memorial rule in the accountancy, which means that it does not always illustrate the certain amount of cash possessed by the enterprise. Therefore, the distinction of profit and direct possession of certain amount of cash (money flows) is one of the significant determinants of the enterprise survival in the nearest term. In the Fig. 5 the formation of Z index depending on the profitability of cropland use (as a relation of net profit to area of cropland) has been presented. It was ascertained that in years 2000–2003 enterprises from the first group, with the lowest profitability of land, in respect of Z index were found in the zone of the insolvency. Only in 2004, these enterprises could be placed in the zone of ambiguous classification in respect of the bankruptcy prognosis. In the case of enterprises' group with the highest profitability of the land, the size of Z index was shaped in upper limits of the zone of ambiguous classification in years 2000–2003, while in the last examined year, this index amounted to 3.57. Furthermore in all investigated years an increasing level of Z index due to the rise of the land profitability was registered. It means that in spite of reservations concerning profit category, enterprises with the highest profitability of land have still been characterized by the lowest bankruptcy probability. In surveyed groups of enterprises no explicit relationships concerning the level of Z index in dynamic perspective were reported. Only in the second group of enterprises in years 2000–2003 unimpeded tendency of the increase of analysed indicator, and in the fourth group its fall to the level of 2.46 in 2003 year, was registered.

The ratio of equity capital profitability was counted as a relation of net profit (losses) to the value of this capital. In all years, the lowest level of Z index had the enterprises with the lowest profitability of the equity capital, in most years reflecting the zone of the ambiguous classification (Fig. 6). Only in year 2000, this index amounted to 0.68, which means the location in the zone of insolvent enterprises. In the remaining groups of enterprises, there were no explicit relations ascertained in the formation of Z index. In the enterprises with the highest profitability of equity capital the Z index was the highest (in whole researched community) only in years 2002–2003 (amounted properly to 2.56 and 2.61). The highest quantity of this indicator, which was ascertained in surveyed years concerned the second group of enterprises – on level of 3.22 in year 2004, which indicates the zone of solvency, in which, in the same year enterprises from the fourth group (3.04) were situated. To sum up, it could be stated that the lowest profitability of the equity capital determines the threat of the enterprise bankruptcy.



	2000	2001	2002	2003	2004
Group I	0,68	1,44	1,51	1,83	1,50
Group II	1,87	2,42	2,36	2,22	3,22
Group III	2,78	2,29	1,72	2,05	2,67
Group IV	2,20	2,19	2,56	2,61	3,04
Average	1,85	1,96	2,00	2,11	2,33

Figure 6 The prognosis of the agricultural enterprises bankruptcy depending on ownership capital yield in %
Source: Own elaboration

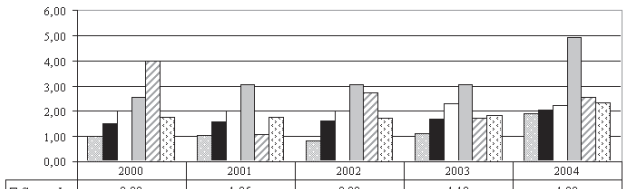
Obrázok 6 Prognóza bankrotu poľnohospodárskych podnikov v závislosti od výnosov vlastníckeho kapitálu v %
Zdroj: Vlastné výpočty
(1) skupina I, (2) skupina II, (3) skupina III, (4) skupina IV, (5) priemer

However, achieving higher effectiveness of profitability of equity capital does not have to reflect a decreasing threat of the enterprise bankruptcy. It could be partly caused by the effect of the financial leverage, thanks to which the higher effectiveness of the equity capital could be obtained through rational participation of outside capital, which on the other hand influences the debts level and relations of capital. Generally, it could be ascertained that beginning with the second group of enterprises the Z index was usually marked in the middle of the zone of ambiguous classification.

In the Fig. 7 the formation of Z index according to the level of current financial liquidity has been presented. This indicator was counted as a relation of current assets to current liabilities. In group of enterprises with the lowest current liquidity ratio in years 2000–2003, the Z index was located in zone of insolvent enterprises. In all examined years, the increase of Z index was registered together with the increase of current liquidity ratio. Beginning from year 2001, in the fourth group of enterprises the degree of Z index reflected the zone of solvent enterprises. The second and third group of enterprises was found in the zone of ambiguous classification. The fact that Z index level was formed in the area of ambiguous classification zone in the group of enterprises without current liabilities (except the year 2000) was considered interesting. One of the reasons of such situation could be higher long-term debts in these enterprises, which is connected to higher incurred financial costs. Besides these enterprises do not use current trade or bank credits, that is why they do not benefit from the financial leverage. It contributes to the fall in profitability of the enterprises' activity and decreases the level of the working capital. In the end, the Z index can be of lower degree. From previous researches arises the fact that enterprises, which do not possess liabilities, were often marked by lower effectiveness of cropland use, work resources and profitability of equity capital (Wasilewski 2005).

Debts of enterprise, from the management point of view, are an essential instrument describing the financial liquidity. The policy of maintaining the level of debts on the rational level should be a tool encouraging contractors to purchase (cooperate), but on the other hand the competence of their retrieval is very important either. In the Figure 8 the changes of Z index depending on the rotation of enterprises' debts were presented. In most of years all groups of enterprises according to the degree of Z index were found in the zone of ambiguous classification. Only in the first group of enterprises in year 2001 and also in the third group in year 2002 appeared the threat of the insolvency. In most of investigated years, the domination of enterprises from the fourth group was visible, whereas the difference in relation to the second group was very marginal. Enterprises from the second group according to Z index level were characterized by domination in years 2001–2002. The reason of such relationships might lie in the concept of strategy in debts management. The average term of the debts turnover could be an encouragement for consumers to cooperate, what generates additional income, and by this also profits. In the case of the highest debts rotation, their turnover in days is shorter. It might lead to better financial condition, but simultaneously it contributes to the decrease of sales income. It could have been suggested that managers of enterprises from the second and fourth group shape the level of debts in rational way. In the case of enterprises without debts (the fifth group) the Z index in year 2004 only, was on the level reflecting enterprises from the solvency zone (3.67).

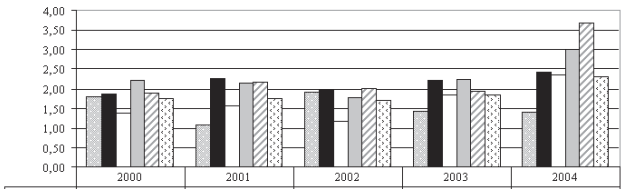
In other years the degree of this index reflected the area of ambiguous classification in this respect – on relatively similar level in selected years. With reference to level of Z index in the fourth group of enterprises (with the fastest debt turnover), in enterprises without debts in general the Z index was on lower levels (except year 2004). It means that the lack of debts is reflects lower sale scale and might be the reflection of its too rigorous conditions. This results in the decline of activity efficiency and makes impossible to ascertain synonymously if the enterprises are solvent or not.



	2000	2001	2002	2003	2004
Group I	0,99	1,05	0,80	1,10	1,90
Group II	1,52	1,59	1,61	1,68	2,06
Group III	2,00	2,00	2,00	2,31	2,24
Group IV	2,55	3,04	3,05	3,04	4,94
Group V	3,97	1,06	2,74	1,71	2,56
Average	1,76	1,75	1,70	1,84	2,32

Figure 7 The prognosis of the agricultural enterprises bankruptcy depending on current liquidity ratio
Source: Own elaboration

Obrázok 7 Prognóza bankrotu poľnohospodárskych podnikov v závislosti od stupňa krátkodobej likvidity
Zdroj: Vlastné výpočty
(1) skupina I, (2) skupina II, (3) skupina III, (4) skupina IV, (5) priemer



	2000	2001	2002	2003	2004
Group I	1,79	1,09	1,93	1,43	1,41
Group II	1,86	2,27	1,99	2,21	2,42
Group III	1,39	1,58	1,16	1,84	2,35
Group IV	2,21	2,15	1,77	2,24	3,01
Group V	1,88	2,17	2,02	1,95	3,67
Average	1,76	1,75	1,70	1,84	2,32

Figure 8 The prognosis of the agricultural enterprises bankruptcy depending on debt turnover ratio
Source: Own elaboration

Obrázok 8 Prognóza bankrotu poľnohospodárskych podnikov v závislosti od stupňa zadĺženosti
Zdroj: Vlastné výpočty
(1) skupina I, (2) skupina II, (3) skupina III, (4) skupina IV, (5) priemer

Conclusions

The elaboration presented Z index formation in Altman model for a group of agricultural enterprises with different law forms of land purpose in relation to chosen features of their classification. On the basis of conducted researches the following conclusions has been formulated:

1. The prognosis of the solvency level in agricultural enterprises is comparatively difficult. The agricultural production depends on natural conditions, the degree of the state intervention on agricultural market, the level of the supply on agricultural products etc. APA companies were on the highest level of Z index, while in enterprises of leaseholders and owners this indicator was placed in lower limits of the ambiguous classification zone. Simultaneously in enterprises with the smallest cropland area, the indicator was the highest. It reflects the problem of investing in the same financial outlays for every hectare of cropland. However, the great importance of enterprises assets in maintaining their solvency was ascertained at the same time, which referred also to participation of the equity capital in the structure of funds.
2. Together with higher level of the profitability of land use Z index also grew. Managers of enterprises should maximize the efficiency of production factor use. Such relationships were not registered in the case of the ownership capital profitability, which depends on relations between the equity and outside capital. The lack of current liabilities in enterprises did not signify explicitly their solvency, because these enterprises were found in the zone of ambiguous classification. However, enterprises with the highest level of current financial liquidity were characterized by the highest Z index, and in general were situated in the zone of solvent enterprises. Liabilities reflect the scale of the enterprise activity – partly they contribute to the increase of their activity effectiveness. However, it is essential to maintain low level of debts. The relations between debts turnover ratio and the level of enterprises' solvency were not ascertained. The importance of the debts management is multifaceted, and its too rigorous vindication could lead to decline of the sale and farming efficiency scale.
3. The Altman's model reflects the situation of agricultural enterprises based on their solvency. These enterprises function on the level of relatively low profitability that is why, according to most of established criteria of their group classification, these enterprises have been found in the zone of ambiguous classification. Agriculture is marked by comparatively high risk of business activity, therefore the assessment of the current solvency of agricultural enterprises is most of all advisable.

Súhrn

Článok podáva analýzu vzťahu medzi indexom Z podľa Altmanovho modelu a vybranými charakteristikami poľnohospodárskych podnikov, ako sú napr. forma vlastníctva pôdy, výmera pôdy, celkový majetok a hodnota vlastníckeho kapitálu, ziskovosť, likvidita a zadĺženosť. Do predkladaného výskumu bolo v rokoch 2000–2004 zahrnutých 118–123 veľkých poľnohospodárskych podnikov. Bolo zistené, že ekonomická predpoveď úrovne platobnej schopnosti poľnohospodárskych podnikov je pomerne náročná. Spoločnosti APA boli charakterizované najvyšším stupňom indexu Z, zatiaľ čo v nájomných podnikoch a podnikoch v osobnom vlastníctve bol tento ukazovateľ na pomerne nízkej úrovni. V podnikoch s najmenšou výmerou pôdy bol tento ukazovateľ najvyšší. Index Z sa relatívne zvyšoval spolu so ziskovosťou rastu využívania pôdy. Takýto vzťah však nebol zaznamenaný v prípade ziskovosti vlastníckeho kapitálu. Nedostatok krátkodobých pasív v podnikoch explicitne nepodmieňoval rast ich platbyschopnosti. Podniky s najvyššou úrovňou krátkodobej likvidity boli charakterizované najvyššou úrovňou indexu Z a vo všeobecnosti sa pohybovali v oblasti platbyschopnosti. Vzťahy medzi indikátorom zadĺženosti a platbyschopnosťou podnikov neboli explicitne potvrdené.

Kľúčové slová: Altmanov index Z, celkový majetok a hodnota vlastníckeho kapitálu, ziskovosť, likvidita, zadlženosť

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Acta oeconomica et informatica 2
Nitra, Slovaca Universitas Agriculturae Nitriae, 2008, s. 56

Z VEDECKÉHO ŽIVOTA FEM: 3. MEDZINÁRODNÉ FÓRUM SLOVAKIA-UKRAINE-POLAND

Peter BIELIK

Slovenská poľnohospodárska univerzita v Nitre

Nie je tomu ani rok, čo FEM SPU v Nitre avizovala kreovanie konzorcia spolupracujúcich ekonomických fakúlt poľnohospodárskych univerzít v rámci triangla krajín: Slovensko – Ukrajina – Poľsko. V súčasnosti sa môže pochváliť jeho rozšírením čo do počtu, ako aj prvými úspechmi a kvalitatívnym rozvojom vzájomne prospešnej spolupráce.

Na pozvanie dekana FEM Dr.h.c. prof. Ing. Petra Bielika sa v období 5.–9. marca 2008 uskutočnilo III. slovensko-ukrajinsko-poľské fórum. Miestom konania bol Liptovský Ján.

Rokovanie III. medzinárodného fóra sa nieslo v duchu hlavnej témy, ktorou bola internacionalizácia vzdelávania a vedeckovýskumnej činnosti. Rokovanie otvoril dekan FEM, prof. Ing. Peter Bielik. Svojim príspevkom poskytol viacero vecných a perspektívnych námetov na zintenzívnenie vzájomnej medzinárodnej spolupráce, s využitím podpory, ktorej sa dostáva zo strany Európskej únie, rozvoja prihraničnej spolupráce či zdrojov Višehradského fondu. Všetci vystupujúci zhodne deklarovali mimoriadny záujem na rozvoji medzinárodnej spolupráce. Viaceré námety smerovali k vytvoreniu spoločného medzinárodného projektu TEMPUS, so zameraním na skvalitnenie manažmentu univerzít, transfer know-how v tejto oblasti, ako aj kreovanie centier celoživotného vzdelávania na vybraných ukrajinských univerzitách. Ako sa vyjadrila dekanka Ekonomickej fakulty Národnej poľnohospodárskej univerzity Ukrajiny z Kyjeva, Tetiana Kaminska, zúčastnila sa už viacerých podujatí podobného charakteru, ale na žiadnom neboli tak vecne a adresne definované zámery ďalšej spolupráce s perspektívou ich realizácie, ako na tomto fóre.

Ako vyplynulo z rokovania sekcií „Internacionalizácia vzdelávania“ a „Internacionalizácia výskumu“, univerzity na Ukrajine riešia podobné problémy ako univerzity na Slovensku a v Poľsku, nakoľko súvisia s implementáciou Bolonského procesu pri organizovaní vysokoškolského štúdia ako aj s rozvojom dištančného a celoživotného vzdelávania (stanovenie počtu kreditov, výber predmetov do študijných programov, financovanie výskumu, výskumné priority, zaťaženosť pedagógov, atď.)

Spoločné problémy a transfer predchádzajúcich skúseností vytvárajú predpoklady pre perspektívnu a vzájomne prospešnú spoluprácu, ktorá už nadobúda konkrétnu podobu, napríklad v podobe organizovania medzinárodného vedeckého workshopu, ktorý sa bude organizovať v spolupráci s Národnou poľnohospodárskou univerzitou Ukrajiny v dňoch 5.–6. novembra 2008 v Kyjeve. Podujatie podporil aj Medzinárodný Vyšehradský fond prostredníctvom projektu prof. Bielika na tému: „Poľnohospodárske trhy a obchod: súčasnosť a perspektívy krajín V4 a Ukrajiny“. Cieľom workshopu bude výmena a transfer skúseností z reštrukturalizácie poľnohospodárskych trhov krajinách V4 a aplikácia získaných poznatkov v praxi agrorezortu Ukrajiny. Workshop sa bude venovať otázkam poľnohospodárskych trhov a dopadu spoločnej poľnohospodárskej politiky na národné poľnohospodárstvo, perspektívam ďalšieho rozvoja agrorezortu v zúčastnených krajinách, vybraným otázkam marketingovej vertikály ako aj aspektom internacionalizácie v podmienkach európskeho i globálneho trhu.

Medzinárodné fórum vyvrcholilo podpísaním Memoranda o porozumení zúčastnených ekonomických fakúlt poľnohospodárskych univerzít. Memorandum podpísalo 9 dekanov z Ukrajiny, 6 dekanov z Poľska, rektor Poľnohospodárskej univerzity v Krakowe, dekan PEF ČZU v Prahe a dekan Fakulty ekonomiky a spoločenských vied Univerzity Sv. Štefana v Gödöllő. Účasť delegácií z Čiech a Maďarska zároveň prispela k teritoriálnemu rozvoju spolupráce partnerov z piatich, navzájom susediacich krajín.

Dr. h. c. prof. Ing. Peter Bielik, PhD.