ACTA UNIVERSITATIS AGRICULTURAE ET SILVICULTURAE MENDELIANAE BRUNENSIS

Volume LVIII 19 Number 6, 2010

ECONOMIC EFFICIENCY OF LEGUME-CEREAL INTERCROPS IN CONDITIONS OF ORGANIC FARMING

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Received: August 23, 2010

Abstract

JÁNSKÝ, J., POSPÍŠIL, J.: *Economic efficiency of legume-cereal intercrops in conditions of organic farming.* Acta univ. agric. et silvic. Mendel. Brun., 2010, LVIII, No. 6, pp. 189–198

The paper presents economic analysis of growing of legume-cereal intercropping in conditions of organic farming. Results of the analysis are based on data monitoring in chosen organic farms that grow LCI. In the paper there is also compared economic efficiency of LCI grown in organic and conventional farming system. Methodological solution results from costingness and earnings monitoring of LCI production in five chosen organic farms in the period 2007–2008.
When evaluating costs existing in individual variants of LCI growing it is necessary to say that the selection of individual machines and machine aggregations represents the most important factor of influencing direct costs, namely with regard to the size of organic farms and to the area of individual field blocks. Under conditions of organic farms, the LCI production is also significantly influenced also by agrotechnical (tillage) operations. As compared with conventional farms, the final yield of both green fodder and grain is lower by 14–38%. Total direct costs per hectare of harvested LCI acreage ranged in case of fodder production from 9.249 CZK to 11.620 CZK per hectare. In case of grain production, the corresponding costs ranged from 8.848 to 9.970 CZK per hectare. In case of LCI, the direct costs of organic farms per unit of production of both fodder and grain consist mainly of material costs, which represent 63–76% and 61–68% of total expenses associated with production of fodder and grain, respectively. These direct costs are influenced also by higher prices of inputs.

economic efficiency of LCI-growing, LCI costs, LCI revenues

The system of organic agriculture, in proportional scope and in chosen conditions, with keeping the principles of environment undamaging and the equilibrium state in organic agricultural systems, it is one of the ways that could play important part for permanent defensibility of agriculture, but with lower revenues. From the definition of the organic farming there especially follows that organic farming is not only simple conventional agriculture where we stop to use synthetic fertilizers and pesticides. It is concerned using of the whole system of measures, such as reduction of period, when land is not covered by vegetation, by using of intercrops, by structure of crops with choice of suitable variety and their right turning in the rotation of crops; sufficient organic fertilizers; prevention in protection against injurious agents and other grower and breeder processes, but especially responsibility of farmer and keeping of directives that organic farming abide by. It explains favourable impacts of this way of farming upon environment.

Growing of legume-cereal intercropping (LCI) in organic farming represents solution of current problems in legume growing in this system of farming (Houba, 2009). It represents production of high quality with reasonable costs and at once also corresponding prices of products. The quality of production and direct costs, that a grower can influence mostly, are especially connected with using of right cultivation technologies (Pospíšil, 2010). It applies also to legume-cereal intercropping. Economic contiguous of legume-cereal intercropping are analyzed in this paper.

Under conditions of organic farming, the arable land is used above all for growing of cereals. At present the share of cereal crops is approximately 55% of the total harvested area. The second position is occupied by fodder crops grown on arable land (32%). Legume-cereal mixtures (LCI) are grown on arable land and (regarding the character of their production) they participate in both groups of aforementioned organic crops.

Economy of LCI growing in conditions of organic farming analyze primarily influence of particular cost items that subsequently notably influence costingness of milk production, production of beef, pork and also other commodities and products.

Recently, legume-cereal mixtures are grown mainly as cash crops in the Czech farming and their use for feeding animals is markedly reduced. The aim of this paper is to evaluate the economic demandingness of growing LCI under conditions of organic farming.

Similarly as in case of other crops, also when evaluating economic aspects of LCI growing, it is not possible to reach acceptable results without consideration of their subsequent use. Expenses associated with production of feedstuffs are an important cost item and for that reason it is necessary to reach high yields of nutrients per hectare and to produce and preserve fodder crops with the minimum losses and costs (Jánský, 2007).

The paper presents results of subproject *A/CZ0046/1/0024* called "Utilizing legume-cereal intercropping to increase self-sufficiency with animal fodder and maintain soil quality on organic farms in the Czech Republic", was financed by the EEA Financial Mechanism, the Norwegian Financial Mechanism, and the state budget of the Czech Republic through the Research Support Fund.

MATERIAL AND METHODOLOGY

When solving this subproject the authors used results of monitoring and evaluation of technical and economical parameters that were investigated on five selected organic farms within the period of 2006–2008. The calculation of production cost (Poláčková, 2010) was based on data about LCI growing technologies used within every concrete farms within a period of several years (i.e. dressing and liming, tillage operations, sowing, treatment in the course of growing season, harvesting, and transportation of the main product, and of by-products).

Evaluation of crop growing economy by using of cost calculation results from the evaluation of only direct costs that were identified and subsequently analyzed in monitored organic farms. Indirect costs including depreciation are not analyzed in this paper with respect to considerable differences among monitored organic farms of natural and corporate person.

The estimation of direct costs per unit production enables also to compare not only different crops but also individual growing technologies used within the framework of one farm. The estimation and knowledge of direct costs also enables to evaluate effects of applied technologies (Kavka, 2006).

So, costs items of individual direct costs represent costs of bought and own seed, costs of own fertilizers, other direct material costs, costs of growing technology (it means labour costs and machinery costs). Direct costs of LCI growing include, as mentioned above, costs of seed, costs of other subsidiary material (foil, cord, conserving substance etc.), costs of fertilization by manure, sewage or composting and also liming (fertilizing is calculated once every four years). Further there are named labour costs (they include labour consumption by particular technological processes and repair costs) and machinery costs (especially consumption of diesel oil); these costs are monitored per particular work and technology operations.

According to suggest methodology of project solving there are monitored farms and technologies using in these farms. Work operations of LCI growing and harvesting in individual organic farms are structured according to output for fodder crop and for grain. Their summary is mentioned in the table I.

Not only direct costs but also earnings influence economy of LCI production. Earnings are equivalent of products in monetary expression out of consideration for payment. It is also difference between earnings (revenues) and monetary receipts. LCI growing is usually connected with subsequently using of mixtures (as a fodder crop or grain) as own intermediate product consumed in livestock production of the organic farm (mainly in beef-raising, eventually in pig breeding) and only rarely are bring to market. That is why it is difficult to calculate earnings of LCI. Under the law No. 563/91 about ac-

I: *Monitored organic farms and technologies*

Organic farm	Growing and harvesting of LCI for fodder crop		Growing and harvesting of LCI for grain	
	Silage	Haylage	Dry grain	Wet grain
A	X			
B	X		X	
C		X		
D		X	X	
E				X

Source: own processing

counting as amended by later regulations the own intermediate product is assessed by own costs incurred in the concrete company.

In the paper there are also analyzed subsidies for organic farms. Subsidies are connected with direct payments and subsidies for organic farming. In the Czech Republic there are direct payment provided from source of EU in the system SAPS per hectare of area under cultivation. There is also possibility to concurrently even up direct payment from national sources (national complementary payments to direct supports – Top-Up). Subsidies into organic farming represent partial agro-organic measures. All above mentioned subsidies are paid per hectare of grown LCI.

Total direct costs and subsidies of LCI growing in chosen organic farms are analyzed and compared among each other and also with farms that grow LCI by conventional way.

RESULTS AND DISCUSSION

When growing LCI for fodder production, altogether 4 technologies (with two variants of preservation each, i.e. production of silage and/or haylage) were followed and analysed on 4 organic farms (A–D). Individual technological operations associated with growing and harvesting of LCI for fodder are presented in Tab. II.

Data presented in this table indicate that each of four organic farms under study used partly different technological operations of growing LCI for fodder (i.e. for silage and/or haylage making); the age of individual machines was different as well.

Economic results of LCI fodder production, as classified according to individual groups of technological operations are summarised in Fig. 1. Technological operations were divided into four groups (crop establishment, operations performed in the course of growing season, harvesting operations, and fertilisation plus liming. The obtained data are presented and grouped as aggregated three-year means of costs concerning establishment of stands, treatment in the course of growing season and during the harvest. Cost of fertilisation and liming were analysed separately.

As shown in Fig. 1, that the highest were costs associated with the establishment of stands and that they

II: *Technology operations LCI growing for fodder crop*

Silage		Haylage	
A	**B**	**C**	**D**
Liming	Liming	Liming	Part of liming
Manuring	Manuring	Manuring	Manuring
Stubble breaking	Stubble breaking	Stubble breaking	Stubble breaking
Ploughing	Ploughing	Harrowing of the stubble breaking	Ploughing
Sowing of intercrop	Harrowing	Ploughing	Sowing by seed combination
Harrowing	Transportation of seed material	Preparing for sowing	Loading of seed material
Mulching	Loading of seed material	Sowing by seed combination	Transportation of seed material
Ploughing	Sowing	Loading of seed material	Mowing
Harrowing	Rolling	Transportation of seed material	Raking
Rolling	Mowing and cutting (chopping)	Mechanical protection	Baling
Transportation of seed material	Transportation of chopped fodder	Mechanical protection	Wrapping of bales
Loading of seed material	Compacting	Mowing	Loading of bales
Sowing	Clamp covering	Turning	Transport of bales
Rolling		Raking	Storage of bales
Harrowing		Baling	
Harvesting by cutting machine		Wrapping of bales	
Silage transportation		Transport of bales	
Compacting		Storage of bales	
Raking			
Clamp covering			

Source: own processing

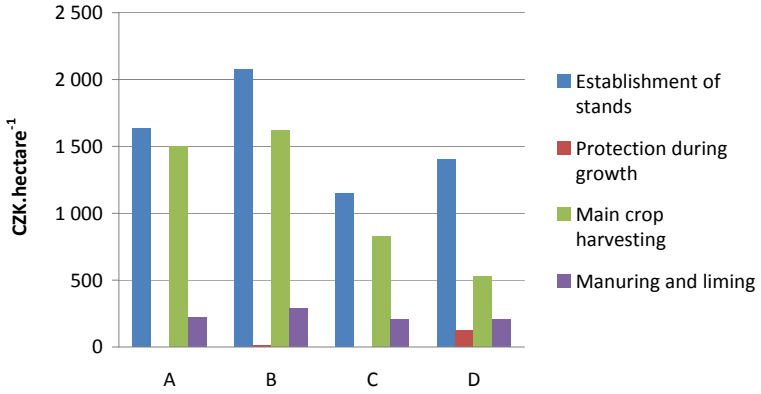
represented 48.7% to 62% of machinery costs (including wages). The second highest group involved harvest operations (23.5% to 44.7%). Harvest costs were influenced above all by increased expenses for harvesting (because of the use of cutting machines) and transportation of harvested material. Costs of treatment (i.e. tillage operations) in the course of growing season were generally very low on all farms under study; only on one farm, where the stands were repeatedly treated by flexible tine harrows, the machinery costs (including wages) made 5.4%. It can be therefore concluded that the height of machinery costs was influenced by the type and by the age of machinery used. These parameters influenced not only consumption of fuel and labour in individual groups of operations but also the repair costs of machines.

Direct costs of LCI growing for fodder on individual organic farms as converted per hectare of harvested area and unit of production are presented in Tab. III.

In case of growing LCI for fodder, direct costs per hectare of harvested area involve material costs (i.e. prices of seed material, manure and lime as calculated once in four years) and prices of ancillary materials (strings, plastic foils and preservatives). Tab. III also contains wages and total machinery costs as calculated for individual technological operations. The harvested volume of LCI fodder is calculated on all organic farms on the base of 33 % of dry matter.

When expressing the share of machinery costs in total direct costs, then on farms growing LCI for either silage or haylage making the calculated values ranged from 24 to 25% and from 34 to 37%, respectively. On organic farm B, the machinery cost plus wages were higher due to the use of costly lorry transportation of harvested material in various working and technological operations. Our calculations of machinery costs on organic farms were based on comparable prices of diesel fuel and lubricants and also on comparable price of labour. These comparable price conditions were selected intentionally for the purpose of comparison of individual technologies used on individual organic farms.

It results from data mentioned above that a substantial part of direct costs consisted of direct material costs (i.e. 63–76%). This means that when growing LCI for fodder, it is necessary to pay attention



Source: own processing

1: *Machinery costs according to group of operations during growing of LCI for fodder crop*

III: *Costs of LCI as a fodder crop*

Costs of LCI as a fodder crop	Units	Silage		Haylage	
		A	B	C	D
Seed material	CZK/hectare	3077	2895	2700	2900
Fertilizers including liming	CZK/hectare	2600	2720	2600	2600
Other direct material	CZK/hectare	1670	1700	1600	2100
Direct material costs in total	CZK/hectare	7347	7315	6900	7600
Labour costs	CZK/hectare	944	826	579	558
Machinery costs	CZK/hectare	2795	3479	1770	1876
Direct costs in total	CZK/hectare	11086	11620	9249	10034
Yield	ton/hectare	16,70	15,20	13,45	16,50
Direct costs of product	CZK/ton	664	764	688	608
Direct material costs in total	CZK/ton	440	481	513	461
Machinery costs including labour costs	CZK/ton	224	283	175	148

Source: own calculation

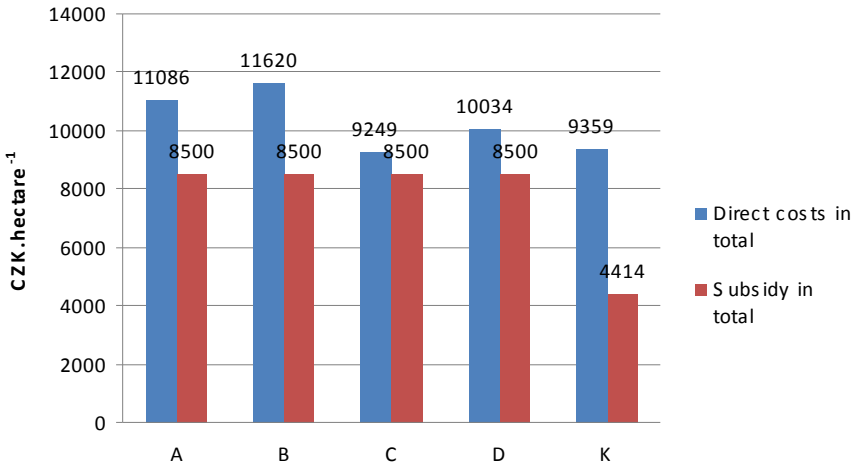
above all to this group of costs because it is more difficult for farms to control and/or regulate material costs on the base of prices of external inputs.

Direct costs associated with growing LCI for fodder on four organic farms and on a group of conventional farms are compared in Figs. 2 and 3 (these costs were calculated per hectare and per unit of production). The obtained results indicate that when calculating these direct costs per hectare of harvested area they were higher on organic farms than on conventional ones (organic farm C represented the only exception). When comparing organic and conventional farms on the base of direct costs per unit of production, the direct costs of production were always higher on organic farms. This was generally valid also for other products because on organic farms the hectare yields were lower. When growing LCI for fodder, the hectare yields of organic farms were lower by 18 to 34%.

When comparing subsidies associated with direct payments and those paid per hectare, it is obvious that on organic farms growing LCI for fodder these subsidies cover 73–79% of direct costs. Subsidies paid to conventional farms for growing LCI for fodder correspond only with direct payments and cover mere 47% of direct costs.

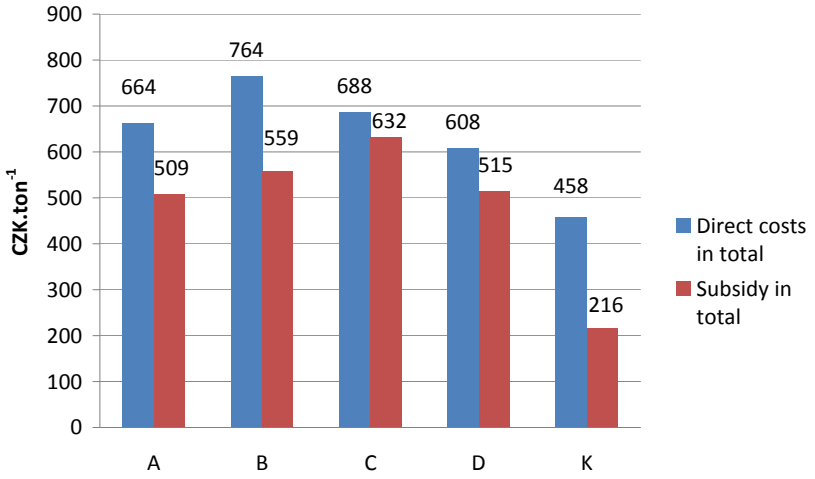
On three organic farms **growing LCI for grain** (B, D, E), the analysis involved two harvesting technologies of grain with moisture content enabling normal method of grain storage and one variant of preservation of wet grain (in the form of silage stored in bags). Individual technological operations of growing and harvesting LCI for grain are presented in Tab. IV. (This analysis involved also the technology of harvesting straw as a by-product).

It results from Fig. 4 that when growing LCI for grain, the highest machinery costs were associated with the establishment of crops (on individual or-



Source: own processing
Remark: A, B, C, D – monitored organic farms; K – conventional farms

2: *Comparison of costs and subsidies of LCI growing for fodder crop in organic and conventional farms (in CZK.hectare^{-1})*



Source: own processing
Remark: A, B, C, D – monitored organic farms; K – conventional farms

3: *Comparison of costs and subsidies of LCI growing for fodder crop in organic and conventional farms (in CZK.ton^{-1})*

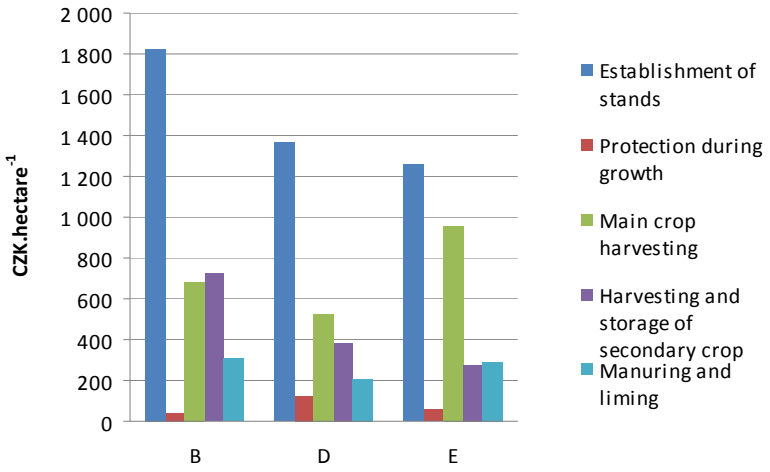
IV: *Technology operations LCI growing for grain*

Dry grain		Moisture grain
B	**D**	**E**
Liming	Liming	Liming
Manuring	Manuring	Manuring
Stubble breaking	Stubble breaking	Stubble breaking
Ploughing	Harrowing of the stubble breaking	Ploughing
Sowing of intercrop	Ploughing	Preparing for sowing
Harrowing	Preparing for sowing	Sowing by seed combination
Mulching	Sowing by seed combination	Transportation of seed material
Ploughing	Transportation of seed material	Loading of seed material
Harrowing	Loading of seed material	Mechanical protection
Rolling	Mechanical protection	Grain harvest
Loading of seed material	Mechanical protection	Grain crushing
Transportation of seed material	Grain harvest	Grain ensiling into sacks
Sowing of intercrop	Grain transportation	Straw harvesting
Rolling	Straw harvesting	Loading of bales
Harrowing	Loading of bales	Transportation of bales
Grain harvest	Transportation of bales	Storage of bales
Grain transportation	Storage of bales	Grain transportation
Straw harvesting		
Loading of bales		
Transportation of bales		
Transportation of bales		
Storage of bales		

Source: own processing

ganic farms the share of these costs ranged from 44% to 52% of total machinery costs). The second most expensive group involved operations concerning harvest of the main crop and harvesting and storage of by-products; their share in the machinery costs ranged from 35 to 43%. The harvest of LCI grown for grain was influenced by higher costs associated with the storage of wet grain.

Direct costs associated with growing LCI for grain were calculated per hectare of harvested area and are presented according to individual organic farms in Tab. V. These costs involve direct material costs, wages and machinery costs. If the share of machinery costs in total costs is calculated per one ton of production then the results obtained on three farms under study range from 32 to 39%. Our calculations



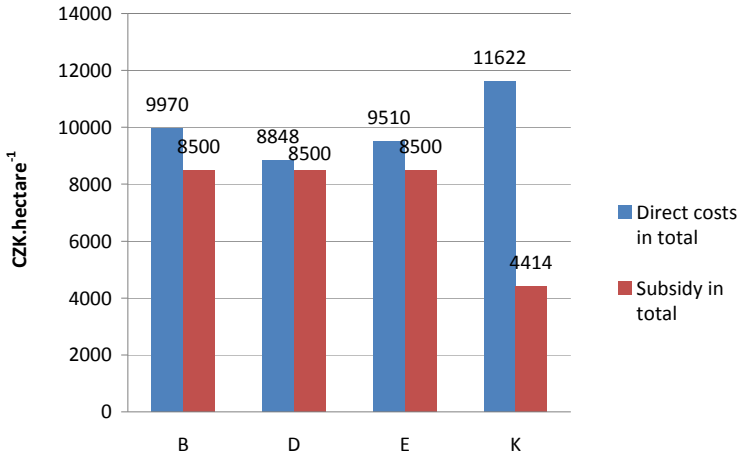
Source: own processing

4: *Machinery costs according to group of operations during growing of LCI for grain*

V: *Costs of LCI for grain*

Costs of LCI for grain in organic farms	Units	Dry grain		Moisture grain
		B	D	E
Seed material	CZK/hectare	2895	2950	2750
Fertilizers including liming	CZK/hectare	2720	2600	2720
Other direct material	CZK/hectare	500	500	970
Direct material costs in total	CZK/hectare	6115	6050	6440
Labour costs	CZK/hectare	765	667	683
Machinery costs	CZK/hectare	3090	2131	2387
Direct costs in total	CZK/hectare	9970	8848	9510
Yield	ton/hectare	3,10	3,50	2,55
Direct costs of product	CZK/ton	3216	2528	3729
Direct material costs in total	CZK/ton	1973	1729	2525
Machinery costs including labour costs	CZK/ton	1244	799	1204

Source: own calculation



Source: own processing
Remark: B, D, E – monitored organic farms; K – conventional farms

5: *Comparison of costs and subsidies of LCI growing for grain in organic and conventional farms (in CZK.hectare^{-1})*

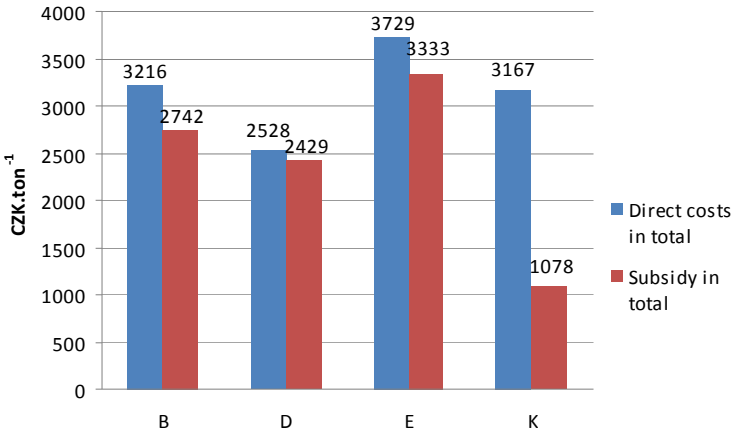
of machinery costs are based on comparable prices of diesel fuel and lubricants plus comparable wages. On individual organic farms the yields of LCI grown for grain ranged from 2.55 t.ha^{-1} to 3.50 t.ha^{-1}.

It results from data presented above that material cost made a substantial part of direct costs and that on three organic farms under study they ranged from 61 to 68%. This means that similarly as in case of growing LCI for fodder, it is also in this case necessary to pay attention above all to these costs.

The comparisons of direct costs associated with growing of LCI for grain on organic and conventional farms are presented in Figs. 5 and 6.

These costs were calculated per harvested hectare and per unit of production. The obtained results indicated that the direct costs of growing LCI for grain, as calculated per hectare, were lower on organic farms than on conventional ones. When comparing organic and conventional farms, higher direct costs per unit of production were recorded only on one organic farm producing dry grain and, naturally, also the farm storing the wet grain in bags. On organic farms under study, the hectare yields of LCI grown for grain were lower by 14–38%.

When comparing subsidies paid for growing LCI for grain on organic and conventional farms it was found out that on the former the subsidies covered 86–96% of direct costs while on the latter they covered only 38% of direct costs.



Source: own processing
Remark: B, D, E – monitored organic farms; K – conventional farms

6: *Comparison of costs and subsidies of LCI growing for grain in organic and conventional farms (in CZK.ton^{-1})*

CONCLUSIONS

When evaluating costs existing in individual variants of LCI growing it is necessary to say that the selection of individual machines and machine aggregations represents the most important factor of influencing direct costs, namely with regard to the size of organic farms and to the area of individual field blocks. As far as other important factors are concerned, the acquisition value of individual machines, their year-round performance (these factors were not followed and evaluated due to great differences in pools of machines) and the age of machinery existing on individual organic farms are also rather important. In case that the year-round performance is lower than the recommended value, the machinery costs may be markedly increased and for that reason it is necessary to consider and decide if it is not economically more advantageous to use services of contractors. Under conditions of organic farms, the LCI production is also significantly influenced also by agrotechnical (tillage) operations. As compared with conventional farms, the final yield of both green fodder and grain is lower by 14–38%.

Total direct costs per hectare of harvested LCI acreage ranged in case of fodder production from 9.249 CZK to 11.620 CZK per hectare. In case of grain production, the corresponding costs ranged from 8.848 to 9.970 CZK per hectare. In case of LCI, the direct costs of organic farms per unit of production of both fodder and grain consist mainly of material costs, which represent 63–76% and 61–68% of total expenses associated with production of fodder and grain, respectively. These direct costs are influenced also by higher prices of inputs. Machinery costs (involving wages) represent 24–37% and 32–39% of direct costs associated with production of LCI for green matter and grain, respectively. As far as the machinery costs classified according to individual technological operations are concerned, the most demanding are operations associated with the establishment of stands because they range from 44% to 62% if total machinery costs. The second most important group involves harvesting operations (23.5–45% and 35–43% when growing LCI for fodder and grain, respectively). On individual organic farms, machinery costs were significantly influenced by the age, performance, and quality of the machine pool.

When comparing organic farms with conventional ones, direct costs of growing LCI (both for fodder and grain) were always higher on organic farms. This conclusion concerned also other organic products due to lower hectare yields obtained in case of organic farming.

Subsidies paid to organic farms in association with direct payments and with support of methods of organic LCI production covered on organic farms under study altogether 73–96% of direct costs. On conventional farms, however, the subsidies of growing LCI represented only 38–47% of direct costs.

SOUHRN

Ekonomická efektivnost pěstování luskovino-obilních směsek v podmínkách ekologického zemědělství

V příspěvku je provedeno ekonomické hodnocení pěstování luskovino-obilních směsek v ekologických podmínkách hospodaření. Výsledky analýzy navazují na sledování dat ve vybraných ekologických podnicích pěstujících LOS. V příspěvku je také provedena komparace ekonomické efektivnosti pěstovaných LOS v ekologických a konvenčních systémech hospodaření. Metodické řešení pří-

spěvku vychází ze sledování nákladovosti a výnosnosti výroby LOS v pěti vybraných ekologických podnicích za časové období let 2007 a 2008.
Při hodnocení nákladů u jednotlivých variant pěstování LOS je nutno zdůraznit, že základním faktorem ovlivňujícím přímé náklady, je již samotný výběr vhodné strojní soupravy, a to především s ohledem na velikost podniku a na velikost honů. Produkce LOS v podmínkách ekofarem je také významně ovlivněna agrotechnikou. Zjištěný konečný hektarový výnos pěstování LOS na zeleno i na zrno je také ve srovnání s konvenčním způsobem pěstování o 14–38 % nižší. Celkové přímé náklady na jeden hektar sklizňové plochy se při pěstování LOS na zeleno u sledovaných ekologických farem pohybovaly ve výši od 9 249 do 11 620 Kč.ha^{-1} a u LOS pěstovaných na zrno od 8 848 do 9 970 Kč. ha^{-1}. Přímé náklady ekofarem na jednu tunu produkce při pěstování LOS na zeleno i na zrno jsou hlavně tvořeny náklady na materiál, a to u LOS pěstovaných na zeleno ve výši 63–76 % a u LOS pěstovaných na zrno ve výši 61–68 %. To znamená, že nezanedbatelný vliv na přímé náklady má také vyšší cena vstupů.

ekonomická efektivnost LOS, náklady LOS, výnosy LOS

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