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The Productivity of Organic Farming in Different Agroecological Conditions

Radka Redlichová, Věra Bečvářová, Karel Vinohradský

Abstract: *The paper presents the results of organic farming productivity in LFA and non-LFA agricultural conditions in the Czech Republic during the period 2001 – 2015. The methodology of the research is based on the comparison of organic and conventional farms development and contains all the FADN file companies.*

In the period 2001 – 2015 have the organic farms reached 30 – 40% of the conventional farms agricultural production intensity. In the LFA conditions reach the organic farms around 25 – 30% of conventional farms agricultural productivity, in the less favourable conditions of non-LFA is the ration around 40%. The different level of land usage intensity between organic and conventional farms, as well as natural conditions associated with soil habitats, is involved by 50 – 60% by the different level of material and labour inputs and by 40% the different productivity of these inputs. Organic farms in the Czech Republic, having the half inputs for 1 ha, create the assumptions of lower environmental burden. However, the total labour and material intensity for one production unit is 1,4 – 1,7 times higher, compared to conventional farms, while the energy intensity is higher 1,7 – 1,8 times. These lead to the less favourable ecological footprint, taking the production for one inhabitant into consideration.

Key words: Organic Farming · Agricultural Intensity · Productivity · Material Intensity · Energy Consumption · Ecological Footprint

JEL Classification: O13 · Q11 · Q12 · Q13

1 Introduction

The organic farming is in the Czech Republic by the state accepted and supported system with 25 years old tradition. The total number of organic farms in 2015 is 4176, the total area of the organic agriculture is 12% of the total agricultural land. The governmental document "The Action Plan of the Czech Republic for the Organic Farming Development for 2016 – 2020" is oriented on the qualitative side of the future development of this system, among others on "the economic viability of organic farms" steaming from the production efficiency and organic products sales increase.

This paper deals with the important part of the organic farming economic efficiency – the productivity of the basic production factors. It presents the part of the research of the economic side of this agricultural sector, solved at the Mendel University in Brno. The aim of the work is the contribution to the decisive relations and connections conditioning the increase of the organic farming productivity, in the Czech Republic.

The attention to the organic farming productivity, as a part of the organic farms management system, has been paid by many of authors. In the discussion part the article refers namely to the works of Ofermann, Nieberg (2000), Sanders (2007), Niggli et al. (2008), Stefanos et al. (2012). The overall concept builds on the monography Redlichová, Bečvářová, Vinohradský (2014).

2 Methods

The source of the data is Farm Accountancy Data Network od the Czech Republic – FADN CZ, managed by the Institute of the Agriculture Economy and Information (Czech abbreviation = ÚZEI) standard outcomes. Total costs are methodological adjusted by adding the sum evaluating the inputs of unpaid work. These costs are signed like "adjusted cost" with the abbreviation "AdC". The indicators used are mainly in common process. The reasoning and reflexions

Ing. Radka Redlichová, Ph.D., Mendel University, Faculty of Regional Development and International Studies, Department of Business and Regional Economy, Zemědělská 1, 61300 Brno, e-mail: radka.redlichova@mendelu.cz

prof. Ing. Věra Bečvářová, CSc., Mendel University, Faculty of Regional Development and International Studies, Department of Business and Regional Economy, Zemědělská 1, 61300 Brno, e-mail: vera.becvarova@mendelu.cz

Ing. Karel Vinohradský, CSc., Mendel University, Faculty of Regional Development and International Studies, Department of Business and Regional Economy, Zemědělská 1, 61300 Brno, e-mail: karel.vinohradsky@mendelu.cz

related to the trend in physical production and input developments are formed, taking the values of price development indexes of productions and inputs into consideration.

The comparison of the levels and trends in Organic Farms (OF) and Conventional Farms (CoF) developments are based on the decomposition of the time series 2001 – 2015 to the trend and residual components. For the trend modelling in the graphs the second order polynomial has been used. In the charts and tables, the trend values for 2001 and 2015 are stated, e.g. so called theoretical values from the trend levelling, further average annual increase and correlation index, allowing the indicative assessment of the annual variations around the trend.

The companies' classification according to the agricultural conditions is also based on FADN CZ data about the land distribution to the LFA (Less Favourable Areas). Because of the low number of the OF in the non-LFA, it was not possible to set the trend values for all the period 2001 – 2015. Therefore, the values are calculated out of the trend of period 2004 – 2015. These value are written in italic.

3 Research results

The development of the intensity of the farming systems is expresses by the changes in the levels of base factors/inputs productivity – land, labour and material. The analysis of the development and level of productivity of the farming system therefore regards the observation namely the indicators and relations listed below:

$i = n * {}_e n$, where:

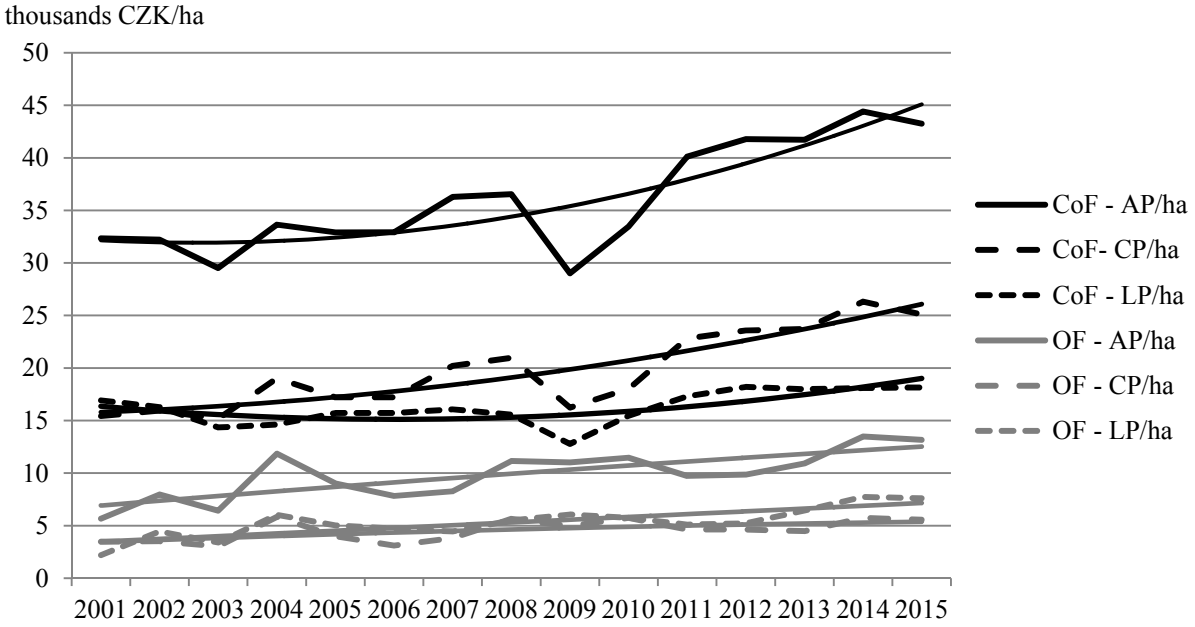
i the productivity, resp. intensity of the land usage and with the soil habitat connected agricultural conditions $i = Q/La$ (Q- the volume of agricultural production; La - the land area)

n the inputs of labour and tangible material (N) for the production unit

e_n the productivity of the labour and material inputs ($e_n = Q/N$).

The productivity of the labour and material inputs (e_n) and the agricultural production / land production intensity develop in the mutual interaction. From the above mentioned equation results that the agricultural production intensity increase could be caused by the input for hectare increase, as well as on the innovations increasing the productivity of these inputs. For the farming systems with higher productivity the qualitative innovations are significant. In this case there are higher level of "i" and "e_n" indicators.

Figure 1 Agriculture production for 1 hectare in OF and CoF



Source: FADN CZ, 2016; own processing

At the end of the observed period have the OF reached around 30 – 40% of the CoF agricultural production intensity (see Chart 1 and Table 1). In the LFA conditions was this ration 25 – 30%, in the non-LFA conditions 30 – 40%. The values of average increases for one hectare, derived from the development trends, show, that this differences have got the tendency to be the same or slightly deeper. The OF intensity in the Czech Republic is even lower compared to EU states like France, Germany and Austria. In these countries is the OF intensity at the level of 40 – 60% compared to the CoF intensity, as reported by Niggli, Slabe, Smid, Halber and Schüter (Niggli et al., 2008).

Table 1 Agriculture, crop and livestock production for 1 hectare

			Number of Farms	AP/ha CZK	CP/ha CZK	LP/ha Kč	LP / AP %
OF	**2001**		38	6 913	3 432	3 480	48.26
	2015		238	12 519	5 365	7 154	56.94
	Δ		x	400	138	262	0.62
	correlation index		x	0.77	0.81	0.81	x
CoF	**2001**		1 166	33 071	15 801	16 357	51.03
	2015		1 140	58 779	26 077	19 012	41.51
	Δ		x	1 836	734	190	-0.68
	correlation index		x	0.87	0.89	0.75	x
OF/CoF 2015			x	0.25	0.22	0.29	x
LFA	**OF**	**2001**	36	6 377	3 387	2 989	45,82
		2015	198	10 272	5 091	7 405	58,14
		Δ	x	278	122	315	0,88
		correl. index	x	0.93	0.81	0.93	x
	CoF	**2001**	661	30 253	13 671	16 582	54,82
		2015	457	39 982	19 128	20 854	51,60
		Δ	x	695	390	305	-0,23
		correl. index	x	0.88	0.87	0.81	x
	OF/CoF 2015		x	0.26	0.27	0.36	x
non-LFA	**OF**	**2004**	9	•	•	•	•
		2015	40	*21 309*	*9 500*	*11 808*	*41,15*
		Δ	x	•	•	•	•
		correl. index	x	•	•	•	*x*
	CoF	**2001**	505	36 618	20 434	16 184	44,44%
		2015	683	50 153	32 793	17 361	34,50%
		Δ	x	967	883	84	-0,71%
		correl. index	x	0.83	0.89	0.40	x
	OF/CoF 2015		x	*0.42*	*0.29*	*0.68*	x

Note: AP = agriculture production; CP = crop production; LP = livestock production; Δ = average annual increase; italics – values are less reliably

Source: FADN CZ, 2016; own processing

The agricultural production intensity depends namely on two groups of factors. The first is based on the volume of inputs for one unit of cultivated land. The second one is based on the factors demonstrating themselves at the productivity level of labour and material inputs. While increasing of the input for one hectare could lead to higher environmental burden, the input productivity increase lead to decrease of labour, material and energy intensity for one production unit, so to the environmentally friendly effect.

The overview of the Czech OF development, based on these factors, is presented at the Table 2 and Figures 2 and 3. According to the data, the OF expend on one hectare 50 – 55% of the CoF costs, while the productivity of these inputs reaches 60 – 70% of CoF. The total difference between OF and CoF is by 55% given by different amount of inputs and by the 45% the different input productivity.

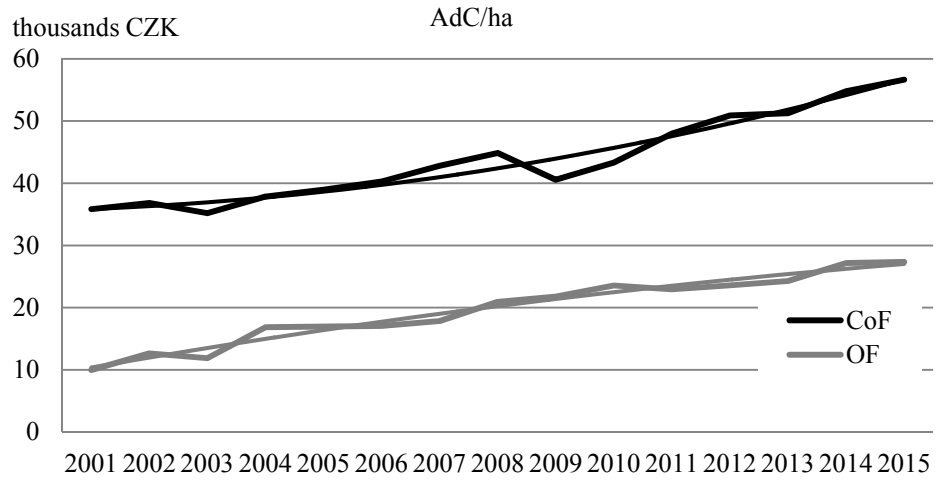
Table 2 The agriculture production intensity, inputs and input productivity

			Number of Farms	AP/ha CZK	AdC/ha CZK	TP/AdC CZK	ha/ AWU	TP/AWU CZK
OF		**2001**	38	6 913	10 368	0.72	61.29	468 934
		2015	238	12 519	27 013	0.54	49.86	661 006
		Δ	x	400	1 189	-0.01	-0.82	13 719
		correlation index	x	0.77	0.98	x	0.69	x
CoF		**2001**	1 166	33 071	35 855	0.98	24.02	858 916
		2015	1 140	58 779	56 703	0.98	35.66	1 798 375
		Δ	x	1 836	1 489	0.00	0.83	67 104
		correlation index	x	0.87	0.98	x	0.98	x
OF/CoF 2015			x	0.25	0.48	0.55	1.40	0.20
LFA	**OF**	**2001**	36	6 377	9 799	0.71	63.35	457 668
		2015	198	10 272	27 077	0.53	46.39	652 626
		Δ	x	278	1 234	-0.01	-1.21	13 926
		correl. index	x	0.93	0.99	x	0.74	x
	CoF	**2001**	661	30 253	33 945	0.97	24.14	810 188
		2015	457	39 982	52 480	0.86	35.17	1 564 063
		Δ	x	695	1 324	-0.01	0.79	53 848
		correl. index	x	0.88	0.97	x	0.96	x
	OF/CoF 2015		x	0.26	0.52	0.62	1.31	0.42
non-LFA	**OF**	**2004**	9	•	•	•	•	•
		2015	40	*21 309*	*33 943*	*0.70*	*17.68*	*499 831*
		Δ	x	•	•	•	•	•
		correl. index	x	•	•	•	•	•
	CoF	**2001**	505	36 618	40 471	0.99	23.05	940 358
		2015	683	50 153	61 032	0.95	34.69	1 914 145
		Δ	x	967	1 469	0.00	0.83	69 556
		correl. index	x	0.83	0.96	x	0.98	x
	OF/CoF 2015		x	*0.42*	*0.56*	*0.74*	*0.51*	*0.26*

Note: AP = agriculture production; AdC = adjusted costs; TP = total production; AWU = average working unit; Δ = average annual increase; italics – values are less reliably

Source: FADN CZ, 2016; own processing

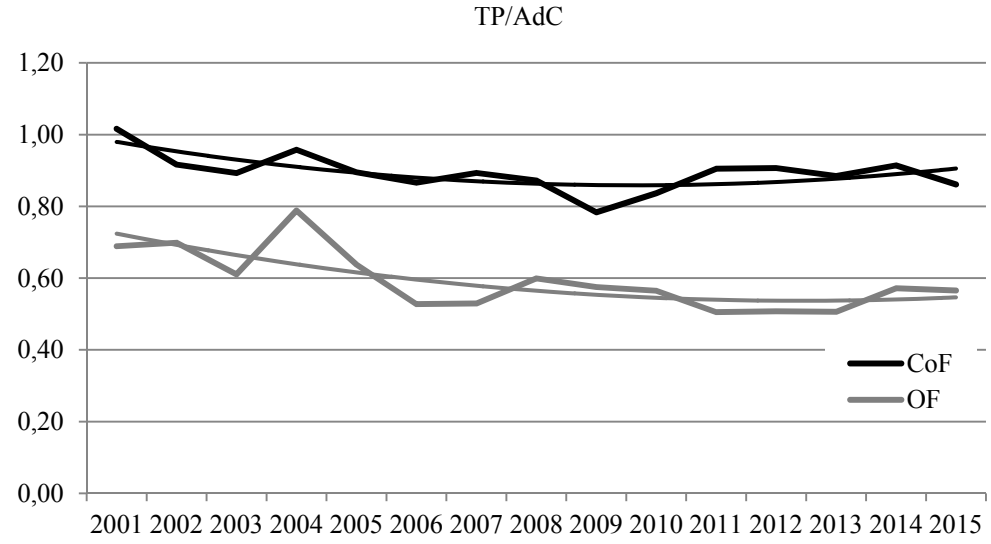
Figure 2 Input for 1 ha in OF and CoF



Note: AdC = adjusted costs

Source: FADN CZ, 2016; own processing

Figure 3 Input productivity in OF and CoF



Note: TP = total production; AdC = adjusted costs

Source: FADN CZ, 2016; own processing

From the character of the biotic part of the technology and technic, of the organic agriculture result the low industry fertilizes consumption as well as means of protection of plants against pests and diseases. Their low presence is the most significant difference in the material input structure and volume between OF and CoF, what can be seen in Table 3.

On the other hand, the abiotic part of the technology and technic of the organic agriculture is based on the mechanisation of production, using the unrenewable energy resources and is almost identical with the mechanisation in the agricultural-industrial systems. In table 4, there are the data presenting this energy consumption. This consumption is in case of OF half for one hectare, compared to the CoF, however, 1.2 – 1.7 times higher taking the one production unit into account.

Table 3 Consumption of fertilizers and plant protection agents in 2015

		Number of Farms	Fertilizers in CZK		Plant Protection Agents in CZK	
			for 1 ha	for 1 000 CZK of the AP	for 1 ha	for 1 000 CZK of the AP
LFA	OF	198	44	4	13	1
	CoF	457	2 828	75	2 148	57
	OF/CoF	x	0.02	0.05	0.01	0.02
non-LFA	OF	40	116	5	403	17
	CoF	683	4 415	93	3 550	75
	OF/CoF	x	0.03	0.05	0.11	0.23

Note: AP = agriculture production

Source: FADN CZ, 2016; own processing

Table 4 Energy consumption for 1 hectare and one production unit in 2015

		Number of Farms	Energy Consumption in CZK	
			for 1 ha	for 1 000 CZK of the TP
LFA	OF	198	2 432	168
	CoF	457	4 189	99
	OF/CoF	x	0.58	1.70
non-LFA	OF	40	3 085	106
	CoF	683	4 660	87
	OF/CoF	x	0.66	1.22

Note: TP = total production

Source: FADN CZ, 2016; own processing

The similar results were reached by Toumisto et. al (2014), Lavrence et al. (2013), Stefanos et al. (2012), who carried out the researches compared the energy consumption of organic and conventional agriculture in the Europe.

4 Conclusions

The organic farms volumes on inputs for 1 hectare are half, compared to the conventional farms. However, total labour and material consumption for one production unit is in the organic farming 1.2 – 1.7 x higher. Lower productivity of organic farming is straight connected with the level of natural resources usage, which is in organic farming only 30 – 40% of conventional farming level. This knowledge imply the "ecological paradox" – by using half of the inputs for 1 hectare, the OF in the Czech Republic produce lower environmental burden of landscape. However, their "ecological footprint" is 1.5 times less favourable while production of food for one inhabitant. These findings are consistent with the similar research of the period 2001 – 2012 (Redlichová, Bečvářová, Vinohradský, 2014). They also pay the attention to the low productivity of organic farming in the Czech Republic and to the fact, that the key change for the productivity increase is the land usage intensification, differentiated according to the agroecological condition character.

The quite similar conclusions are reached also by the authors dealing with the economic structure of organic farming from other European countries, namely Niggli (2008), Offerman, Nieberg (2000). These authors see the way to the economic sustainability of organic agriculture in the production intensification on the basis of organic principles. They use the term ecological intensification of organic food production.

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