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**EFFICIENCY OF AGRICULTURAL ENTERPRISES
 OF VARIOUS ORGANIZATIONAL AND LEGAL FORMS
 AND THE SIZE OF LAND USE**

The article describes the DEA method for measuring and evaluating the activity efficiency of agricultural enterprises. Economic efficiency of agricultural enterprises of various legal forms in the Kharkiv region is studied. The ways of quantitative improvements of inefficient agricultural enterprises are outlined. The influence of the land use volume on technical, allocative and overall efficiency is investigated.

Keywords: economic efficiency; agricultural productivity; data envelopment analysis (DEA); land use.

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ЕФЕКТИВНІСТЬ АГРАРНИХ ПІДПРИЄМСТВ РІЗНИХ
ОРГАНІЗАЦІЙНО-ПРАВОВИХ ФОРМ І РОЗМІР
ЗЕМЛЕКОРИСТУВАННЯ

У статті описано застосування DEA для вимірювання й оцінювання ефективності діяльності суб'єктів господарювання. На основі цього методу досліджено економічну ефективність аграрних підприємств різних організаційно-правових форм у Харківській області. Вказано на кількісні можливості поліпшення діяльності неефективних аграрних підприємств. Досліджено вплив розміру землекористування на технічну, аллокативну й загальну ефективність.

Ключові слова: економічна ефективність; продуктивність аграрного виробництва; метод аналізу оболонки даних (DEA); землекористування.

Табл. 3. Літ. 11.

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ЭФФЕКТИВНОСТЬ АГРАРНЫХ ПРЕДПРИЯТИЙ
РАЗЛИЧНЫХ ОРГАНИЗАЦИОННО-ПРАВОВЫХ
ФОРМ И РАЗМЕР ЗЕМЛЕПОЛЬЗОВАНИЯ

В статье описано использование DEA для измерения и оценки эффективности деятельности субъектов хозяйствования. На основе этого метода исследована экономическая эффективность аграрных предприятий различных организационно-правовых форм в Харьковской области. Указано на количественные возможности улучшения деятельности неэффективных аграрных предприятий. Исследовано влияние размера землепользования на техническую, аллокативную и общую эффективность.

Ключевые слова: экономическая эффективность; производительность аграрного производства; метод анализа оболочки данных (DEA); землепользование.

Introduction. In today's Ukraine, after two decades of independence and market economy transformations some practical experience in terms of various forms of management in agriculture has been accumulated, so we can compare their cost efficiency. In agro-economic science there is a number of discussions concerning legal forms within agricultural sector, their efficiency and viability. One of the most effec-

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tive methods for measuring the efficiency of entities is the method of DEA (data envelopment analysis), according to which three types of efficiency are distinguished: technical, allocative (resource allocation) and overall economic efficiency (Andriychuk, 2005). There is a clear need to expand and deepen the research using the DEA method in different areas of agriculture and for different forms of management that will serve as the basis for strengthening the economy.

Recent research and publications analysis. The first successful attempt to operationalize the theoretical concept of efficiency was made by M. Farrell (1957), who was the originator of DEA. Currently, this method is significantly improved and widely used in all sectors of the economy of Western countries, in particular, in agriculture (Ajao and Salami, 2012; Diaz et al., 2004; Lissitsa and Babycheva, 2003). In recent years, it started to gain popularity in Ukraine (Andriychuk, 2005; Andriychuk and Andriychuk, 2011; Galushko et al., 2004). In particular, coauthors of this article made an assessment of agricultural enterprises efficiency in Lviv region using this method (Pasichnyk et al., 2014). At the same time there are unresolved research issues on the efficiency of agricultural enterprises of different organizational forms using DEA and the influence of the land use volume on technical, allocative and overall efficiency.

The purpose of the article is to demonstrate the opportunities of DEA method in determining the economic efficiency of agricultural enterprises of various legal forms and identify the influence it makes on the land use volume at the regional level.

Key research findings. Considering the authors' positive experience in using the method of DEA in the study of agricultural enterprises in Lviv region (located in Polissia (forest zone)), we have set a new task – to test this method on the Kharkiv region, which is located in the Forest-steppe and Steppe zones to find out the features of efficiency formation.

Using great opportunities of DEA method in measuring the efficiency of agricultural enterprises of different organizational forms we explored the activity of farms (F), private (PE), state (SE) enterprises and joint stock companies (JSC), limited liability company (LLC) and cooperatives (C) which carried out their agricultural activities in the Kharkiv region during 2011–2013.

To calculate the efficiency and total productivity of factors at agricultural enterprises of the Kharkiv region the following resources were used: planting area under crops; the average number of workers employed by agricultural enterprises; material costs (fuel, feed, seed, fertilizers etc.). According to the result of agricultural enterprises the total marketable products are taken (cash proceeds from the sale of all types of agricultural products).

Solving the problem of optimization was carried out using DIAP Version 2.1 (www.uq.edu.au) on the data of 536 agricultural enterprises of the Kharkiv region in 2011, 513 enterprises – in 2012 and 526 – in 2013. According to the results we calculated technical, allocative and overall economic efficiency for each company. It was found that the indicators of these types of efficiency by input-output-oriented model in the context of agricultural enterprises significantly vary in space and time. More information about the differentiation between the studied enterprise indicators of efficiency on the basis of the data is presented in Tables 1–2.

Table 1. Distribution of agricultural enterprises of the Kharkiv region by the indicators of efficiency (input-oriented model), authors' calculations based on the form # 50 «The main economic indicators of agricultural enterprises' activity» (Key economic indicators of agricultural production in the agricultural enterprises for 2013, 2014)

Enterprise type	Intervals of indicators of technical efficiency			Intervals of indicators of allocative efficiency			Intervals of indicators of total efficiency															
	to 0.4	to 0.55	to 0.7	to 0.4	to 0.55	to 0.7	to 0.4	to 0.55	to 0.7	to 0.85	to 0.99	to 1										
2011																						
F	51	6	1	1	1	49	3	2	0	1	5	3	5	7	21	21	3					
PE	136	12	4	1	1	114	23	9	1	0	8	9	9	22	45	65	5					
SE	21	3	0	0	0	15	7	2	0	0	0	4	4	4	4	8	0					
JSC	14	3	1	0	0	12	4	1	0	0	2	1	1	5	2	6	4					
LLC	235	19	4	4	1	211	24	15	4	0	11	10	20	55	58	102	20					
C	10	1	0	0	0	7	2	0	0	1	3	2	3	2	2	2	2					
Total	467	44	10	6	2	408	63	29	5	2	29	29	42	95	132	204	34					
Average value 0.342													Average value 0.771						Average value 0.253			
2012																						
F	59	1	0	0	0	59	1	0	0	0	0	2	2	15	15	16	9	3				
PE	141	4	0	0	1	114	17	8	3	1	4	51	14	25	22	25	10					
SE	20	0	0	0	0	17	1	0	1	1	2	5	2	3	1	4	7					
JSC	22	2	1	0	0	20	3	1	1	0	1	5	1	4	2	9	5					
LLC	234	7	3	1	0	204	17	14	5	1	6	54	19	30	58	64	22					
C	10	0	0	1	0	9	0	0	0	2	0	1	1	1	4	4	0					
Total	486	14	4	2	1	423	39	23	10	5	13	118	52	78	103	115	47					
Average value 0.259													Average value 0.655						Average value 0.143			
2013																						
F	60	1	0	0	0	58	1	2	0	0	0	0	3	9	17	28	4					
PE	139	3	1	0	0	102	17	15	2	4	4	31	16	28	29	35	5					
SE	19	0	1	2	0	13	0	4	0	1	5	4	2	3	10	3	1					
JSC	19	3	0	1	0	12	9	1	1	0	1	3	3	3	5	6	4					
LLC	242	9	4	1	1	189	31	22	5	3	10	29	32	41	54	90	14					
C	13	0	1	0	0	9	1	0	2	1	1	4	0	0	3	7	0					
Total	492	16	7	4	1	383	59	44	10	9	21	71	56	84	118	169	28					
Average value 0.349													Average value 0.709						Average value 0.219			

Table 2. Distribution of agricultural enterprises of the Kharkiv region by reached value of efficiency indicators (output-oriented model), authors' calculations based on the form # 50 «The main economic indicators of agricultural enterprises' activity» (Key economic indicators of agricultural production in the agricultural enterprises for 2013, 2014)

Enterprise type	Intervals of indicators of technical efficiency			Intervals of indicators of allocative efficiency			Intervals of indicators of total efficiency												
	to 0.4	to 0.55	to 0.7	to 0.4	to 0.55	to 0.7	to 0.4	to 0.55	to 0.7	to 0.85	to 0.99	to 1							
2011																			
F	47	8	1	1	1	1	2	0	5	17	21	14	3	3	5	7	21	21	3
PE	116	23	10	1	1	4	4	3	15	43	49	37	8	9	9	22	45	65	5
SE	17	5	2	0	0	0	0	0	3	5	6	9	1	4	4	4	4	8	0
JSC	11	4	3	0	0	1	7	0	1	6	6	5	1	1	1	5	2	6	4
LLC	197	40	13	7	1	7	2	39	86	90	40	40	8	10	20	55	58	102	20
C	9	1	0	0	0	3	0	2	5	2	2	2	2	2	3	2	2	2	2
Total	397	81	29	9	3	17	5	65	162	174	107	107	23	29	42	95	132	204	34
Average value 0,346										Average value 0.728				Average value 0.253					
2012																			
F	56	4	0	0	0	0	0	6	9	11	14	11	9	2	15	15	16	9	3
PE	128	13	2	0	1	3	28	21	10	16	16	39	33	51	14	25	22	25	10
SE	18	1	1	0	0	2	7	3	3	3	3	3	3	5	2	3	1	4	7
JSC	18	4	3	0	0	1	13	1	0	4	4	4	4	5	1	4	2	9	5
LLC	205	25	6	2	3	6	78	33	32	26	47	47	31	54	19	30	58	64	22
C	10	0	0	1	0	0	1	3	3	3	3	0	1	1	1	1	4	4	0
Total	435	47	12	3	4	12	133	70	59	66	104	104	81	118	52	78	103	115	47
Average value 0,248										Average value 0.659				Average value 0.143					
2013																			
F	48	10	2	1	0	0	0	1	16	36	8	0	0	0	3	9	17	28	4
PE	124	8	6	0	2	4	7	25	46	34	34	28	4	31	16	28	29	35	5
SE	14	0	2	1	1	5	5	3	6	5	5	3	1	4	2	3	10	3	1
JSC	13	7	2	1	0	1	0	10	3	2	6	6	3	3	3	3	5	6	4
LLC	180	48	12	9	1	10	9	69	84	42	46	46	10	29	32	41	54	90	14
C	12	0	0	1	0	1	1	2	6	4	4	1	0	4	0	0	3	7	0
Total	391	73	24	13	4	21	23	125	181	95	84	84	18	71	56	84	118	169	28
Average value 0,348										Average value 0.666				Average value 0.219					

The analysis results using DEA show that only 7 companies in the region in 2011 and 6 enterprises in 2012–2013 used the most of available resources, thus reaching the highest level of technical efficiency. It should be noted that all distributions are bimodal, meaning all types of agricultural enterprises have a relatively small group of undertakings with high efficiency and relatively large group of inefficient enterprises.

The majority of companies in the region are low or not enough technically efficient. It means that such enterprises, like the first group of enterprises from Table 1 (467 in 2011, 486 in 2012 and 492 in 2013) can reduce the use of resources by 60% as compared to their actual expenditure and provide the same amount of commodity production, which they have reached in the relevant year.

The average value of technical efficiency in all cases turned twice less that allocative efficiency, i.e. the majority of agricultural enterprises carried out resource allocation approaching its most rational variant.

If in 2011 only 34 enterprises were cost-effective on 100% (being on the verge of production capacity), in 2012 their number increased to 47, in 2013 it decreased to 28. However, technical efficiency in the region overall in fact did not change, and in the dynamics it was lowest in 2012.

As technical efficiency for variable effect of scale in the output-oriented model is lower than the constant technical efficiency under constant effect of scale, the enterprises of the region, changing the scale of production, are able to increase their efficiency.

Using the obtained data we can conclude that efficiency of agricultural enterprises is determined, rather, by the level of management than by the legal form of a company, because despite the structural shortcomings of state or cooperative ownership, some leaders are apparently effective in their work (e.g., in 2012 31.8% of state enterprises had the overall efficiency factor of 1 and in 2013 50% of cooperatives had the overall efficiency of more than 0.85). Thus they are able to get better results than farms and private enterprises, even though private property, according to economic theory, should encourage more efficient use of resources.

The size of land use influenced the formation of efficiency parameters at agricultural enterprises in different ways (Table 3). For example, technical efficiency generally tended to increase with increasing land use, while allocative efficiency decreased, thus influencing the total efficiency fluctuations. Enterprises of the first group with the area of 500 ha were characterized by the highest revenue per 1 ha, technical and total efficiency under input-oriented model and overall efficiency for output-oriented model. Relatively high efficiency in this group was formed through specialization, because here we had a highly specialized company (poultry), with a small area of farmland and large proceeds from sales.

The correlation analysis of the data revealed a strong positive correlation of land use volume with technical efficiency ($r = 0.815$) and negative one with allocative efficiency ($r = -0.785$) under output-oriented model, while other parameters of agricultural enterprises efficiency area correlated weakly. If to remove the indicators of the first group from the correlation analysis, the relationship is much closer.

Another determining factor in forming the efficiency of agricultural enterprises is production technologies. The key purpose of land reform in our country was to provide real owners for the land that would not only promote technological and eco-

Table 3. Formation of efficiency at agricultural enterprises of the Kharkiv region with different volume of land use), authors' calculations based on the form # 50 «The main economic indicators of agricultural enterprises' activity» (Key economic indicators of agricultural production in the agricultural enterprises for 2013, 2014)

Indicators	Groups of enterprises by land use volume, ha										On average
	Up to 500	501–1000	1001–1500	1501–2000	2001–3000	3001–4000	4001–6000	More than 6000			
Number of enterprises in the group, units	93	84	81	63	84	49	38	34			526
Share of the group, %	17.7	16.0	15.4	12.0	16.0	9.3	7.2	6.5			100.0
Agricultural lands of the enterprise, ha	276	738	1245	1696	2452	3475	4877	9817			2264
Revenue, UAH/ha	33704	4872	5365	5747	5085	5279	6701	6299			6394
<i>Average indicators of efficiency by DEA method under input-oriented model</i>											
Technical efficiency	0.611	0.340	0.250	0.270	0.244	0.245	0.370	0.424			0.349
Allocative efficiency	0.427	0.636	0.793	0.883	0.887	0.815	0.676	0.590			0.709
Total efficiency	0.261	0.216	0.198	0.238	0.216	0.200	0.250	0.250			0.219
<i>Average indicators of efficiency by DEA method under output-oriented model</i>											
Technical efficiency	0.364	0.257	0.292	0.376	0.357	0.343	0.446	0.483			0.348
Allocative efficiency	0.777	0.850	0.685	0.606	0.579	0.569	0.528	0.483			0.666
Total efficiency	0.283	0.218	0.200	0.228	0.207	0.195	0.235	0.233			0.232

onomic efficiency, but also care about soil fertility (environmental efficiency). However, according to V. Medvedev (2015) we should recognize that this objective is not achieved because the yield these days is much lower than the potential one, and soil fertility is decreasing. The key issues in land reform are property related, but not technology or soil fertility, sadly. Therefore, the strategic direction in completing the land reform should be soil fertility reproduction through the use of high-tech sustainable agriculture and inadmissibility of any actions harmful to soils, regardless the form of ownership.

Conclusions. The results of our analysis show low level of technical efficiency for all legal forms of management in agriculture. Certain improvements in overall efficiency are unstable and it is too early to speak about improvement trend. Data analysis shows how and in which direction inefficient enterprises need to improve their performance. The calculation results demonstrate that agricultural enterprises of all legal forms have the potential to increase production without additional resources, but only by improving management efficiency and resource allocation. In general, larger land enterprises usually reach higher technical efficiency, but they are less efficient allocating their resources, that are traditionally the reserve for increasing the overall efficiency.

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