

ANATOLIY KUCHER
Institute of Agrarian Economy Kyiv

ESTIMATION OF EFFECTIVENESS OF USAGE OF LIQUID ORGANIC FERTILIZER IN THE CONTEXT OF RATIONAL LAND USE: A CASE STUDY OF UKRAINE

KEYWORDS: liquid organic fertilizer, economic effectiveness, cost, coefficients of payback, pig farm, oat, potential soil fertility, Ukraine

ABSTRACT: The purpose of the article – to perform comparative analysis of the economic effectiveness of the 10 samples of organic fertilizer of pig farm, bio humus “Humivit” and mineral fertilizers (Nitroamofoska, ammonium nitrate, carbamide) on the example of oats. The study used the following methods: abstract-logical, cash-analytical, cash-equivalent, expert, monographic. The research was done in Ukraine. The results of the comparative analysis of economic effectiveness of the 10 samples of organic pig fertilizer, bio humus “Humivit” and mineral fertilizers (Nitroamofoska, ammonium nitrate, carbamide) in the example of oats on the green mass show that the use of organic fertilizers sample number 1, 2, 3, 4, 5, 6, 10 is an economically effective, while organic fertilizers of sample number 7, 8, 9 are economically inefficient. By the main indicators of economic effectiveness (coefficients of payback, conditional additional profit, level of profitability) organic fertilizers sample number 1, 2, 3, 4, 5, 6, 10 have significant competitive advantages over the studied brands of mineral fertilizers and bio humus “Humivit”. The use of organic pig fertilizers, except the sample number 8, in economic terms for the impact on potential soil fertility is more effective than bio humus “Humivit”. The most significant economic benefits for the impact on potential soil fertility are samples of organic fertilizers pig number 1, 5, 10, whose application generates the lowest cost price of humus. The element of novelty is that with using the author’s scientific and methodical approach it was conducted the estimation of economic effectiveness of the liquid organic fertilizer of pig farm for the impact on potential soil fertility.

1. Introduction

The economic justification for the use of organic fertilizers could ensure simplification of decision-making. Naturally, such study should be based on a model which is based on scientific and methodological tools that integrates fundamental agriculture laws and economy laws. However, the economic aspects of the use of organic fertilizers, including liquid manure remain poorly understood, which determined the relevance of this study.

Analysis of recent research and publications shows that V. N. Bosak (2005, 2010), I. M. Bohdevych (2010), A. M. Moskalenko (2013), O. Lushnikova (2015), O. V. Sendetska (2013), O. V. Khodakivska (2010), A. Dubey, D. K. Dubey, E. Enujeke, I. M. Ojeifo, G. U. Nnaji (2013), T. Leah, N. Leah, K. Leibold, T. Olsen, R. Massey, M. Schmitt, G. Rehm, S. Soeparjono (2016) pay attention the issue of the effectiveness of organic fertilizers. In our previous studies identified projections (tentative) indicators of economic effectiveness (cost savings) applying liquid pig organic fertilizers for example crops such as corn, winter wheat (Kucher 2016). The proposed article is a logical continuation of the mentioned research with extension subject field towards rational use of land.

2. The purpose of the article

To perform comparative analysis of the economic effectiveness of the 10 samples of organic fertilizer of pig farm, bio humus “Humivit” and mineral fertilizers (Nitroamofoska, ammonium nitrate, carbamide) on the example of oats.

3. The main research results

Comparative analysis of the economic effectiveness of the 10 samples of organic fertilizer of pig farm, bio humus “Humivit” and mineral fertilizers (Nitroamofoska, ammonium nitrate, carbamide) on oats is based on the experimental obtained data in the result of growing experiment by the Department of Agrochemistry of National Scientific Center «Institute for Soil Science and Agrochemistry Research named after O. N. Sokolovsky» under the leadership of L. O. Shedey to determine the biological effectiveness of different types of fertilizers on oats (Shedey/Kucher and other 2016).

According to the economic service of pig farm, the costs of liquid organic fertilizers are 13 UAH/t. Given that the cost of organic fertilizers depending on the farm ranged from 5.27 UAH/t to 7.90 UAH/t, selfcost (including the cost for application) of organic fertilizers depending on the farm and a way of making ranges from 18.27 UAH/t to 20.90 UAH/t in the future to make economic calculations by the variant approach in the optimistic version manure cost is 18.27 UAH/t, and the pessimistic version – 20.90 UAH/t.

The costs on application of solid organic fertilizers (sample number 1, 5, 10) are at a rate of 16.13 UAH/t (Cherenkov/Rybka and other 2014, 49). Given the cost of organic fertilizers for the calculation of the costs of application of solid organic fertilizer are by the optimistic variant at 21.40 UAH/t, and the pessimistic version – 24.03 UAH/t.

The average wholesale price of Nitroamofoska ($N_{24}P_{24}K_{24}$) as of 1.11.2015 in Ukraine totaled 9000 UAH/t, ammonium nitrate – 7000 UAH/t, carbamide – 7800 UAH/t (Monitoring 2016). The cost for application as in the previous phase of the study, made in the amount of 1350 UAH/t, which together with the cost of fertilizers does not exceed the upper limit of the market price of these fertilizers.

To calculate the average price of “Humivit” was taken which was 7.11 UAH/kg. For comparability by the analysis of indicators of the cost for application “Humivit” made was 13 UAH/t.

Thus, each of the variants of the experiment on the basis of the data it was determined the total cost for application the corresponding amount of fertilizer, the results in Table 1.

Table 1. Indicators of costs for the use of organic fertilizers of pig farm, bio humus “Humivit” and mineral fertilizers on example of oats for green fodder

Variant	Norm on 1 ha, kg phys. weight	Cost of fertilizers, UAH/ha		Expenses for application, UAH/ha	Total costs, UAH/ha	
		Pes. variant	Opt. variant		Pes. variant	Opt. variant
1) Without fertilizers (control)	–	–	–	–	–	–
2) Nitroamofoska, $N_{24}P_{24}K_{24}$	150	1 350.00	1 350.00	202.50	1 552.50	1 552.50
3) Ammonium nitrate, N_{24}	69	483.00	483.00	93.15	576.15	576.15
4) Carbamide, N_{24}	52	405.60	405.60	70.20	475.80	475.80
5) Bio humus “Humivit”	1 333	9 477.63	9 477.63	17.33	9 494.96	9 494.96
6) Sample № 1	3 871	30.58	20.40	62.44	93.02	82.84
7) Sample № 2	7 742	61.16	40.80	100.65	161.81	141.45
8) Sample № 3	5 714	45.14	30.11	74.28	119.42	104.39
9) Sample № 4	5 333	42.13	28.10	69.33	111.46	97.43
10) Sample № 5	2 963	23.41	15.62	47.79	71.20	63.41
11) Sample № 6	9 600	75.84	50.59	124.80	200.64	175.39
12) Sample № 7	10 909	86.18	57.49	141.82	228.00	199.31
13) Sample № 8	17 143	135.43	90.34	222.86	358.29	313.20
14) Sample № 9	9 600	75.84	50.59	124.80	200.64	175.39
15) Sample № 10	2 963	23.41	15.62	47.79	71.20	63.41

Source: author's calculations.

Thus, the calculation results strongly suggest that the expenses of the use of organic pig fertilizers taking into account their cost are lower than costs of the use of mineral fertilizer and about 30 times less than the cost of applying bio humus “Humivit”.

Based on experimental data on the yield of oats on the green mass there were calculated basic indicators of economic effectiveness of the application of studied organic and mineral fertilizers. By performing calculations to determine the value of green mass of oats it was based on the price of grain oats as of 1.12.2015 – 232.77 UAH/c (State 2015, 15), which is converted to the required dimensions using nutrient medium. Recalculation made by regulatory evaluation of forage quality green mass in accordance with methodological recommendations on the calculation of costs of feed livestock and poultry in farms of all categories approved by the State Statistics Committee of Ukraine of 24.01.2008 # 18 (State 2008). So, in 1 c of green mass of oats contains an average of 0.18 c feed. units., the price of 1 c of green mass of oats is 41.90 UAH.

The results of the research (tab. 2) indicate significant differences in terms of economic effectiveness as the samples of organic fertilizers from different pig farms together and compared with mineral fertilizers and bio humus “Humivit” due primarily to different their influence on the yield of oats on the green mass. For example the use of carbamide and samples of organic fertilizers number 8 and 9 of pig farm had no beneficial effect on productivity, resulting in these ways, it was even lower than the control, not provided forming a positive economic effect. Thus, based on these data it can be noted that the use of carbamide and samples of organic fertilizers number 8 and 9 are economically ineffective and impractical.

The greatest value of the conditional additional income (934.37 UAH/ha) was obtained by the application of organic fertilizer of the sample number 3 by the biggest increase in yield (22.3 t/ha), which ultimately provide the greatest mass of conditional additional profit by the pessimistic (814.95 UAH/ha) and optimistic scenarios (892.98 UAH/ha), but the highest level of conditional profitability achieved in the version applying organic fertilizer of samples number 10 and number 3 due to the relatively lower their cost.

If we compare the economic effectiveness of organic pig fertilizers with those of Nitroamofoska, by the criterion for the maximum additional income more effective sample are number 2, 3, 4, 6, and compared to ammonium nitrate, in addition to these samples, and sample number 10. But because of the relatively high cost of mineral fertilizers on these variants there was not ensured formation of additional profit, that is the ultimate application of fertilizers was inefficient too.

If we compare the economic effectiveness of organic pig fertilizers with those of bio humus “Humivit”, then by the criterion of maximum additional income more effective than bio humus were examples of number 2, 3, 4, 6, but because of very high cost of applying bio humus “Humivit” was also economically inefficient, and in this embodiment formed the greatest amount of conditional loss calculated per hectare.

Therefore, based on comparative analysis of economic effectiveness of the 10 samples of organic pig fertilizer, bio humus “Humivit” and mineral fertilizers (Nitroamofoska, ammonium nitrate, carbamide) in the case of oats on the green

mass, it may be noted that: firstly, the use of organic fertilizer sample number 1, 2, 3, 4, 5, 6, 10 was cost effective; secondly, the use of organic fertilizers sample number 8, 9 was economically inefficient because of lack of a positive impact on productivity and organic fertilizers sample number 7 is inefficient because of the relatively low growth of productivity (it is interesting that in the same growth pattern number 1 was effective), but the optimistic variant was achieved almost break-even level, that is reserve for improvement.

Table 2. Indicators of oriented economic effectiveness of pig organic fertilizer compared with bio humus "Humivit" and mineral fertilizers on example of oats on green fodder

Variant	Yield, c/ha	Increase before control, c/ha	Value of increase (additional income), UAH/ha	Conditional additional profit, UAH/ha		Level of conditional profitability, %	
				Pes. variant	Opt. variant	Pes. variant	Opt. variant
1) Without fertilizers (control)	89.8	-	-	-	-	-	-
2) Nitroamofoska, N ₂₄ P ₂₄ K ₂₄	106.4	16.6	695.54	-856.96	-856.96	-55.2	-55.2
3) Ammonium nitrate, N ₂₄	101.5	11.7	490.23	-85.92	-85.92	-14.9	-14.9
4) Carbamide, N ₂₄	81.8	0.0	0.00	-475.80	-475.80	-100.0	-100.0
5) Bio humus "Humivit"	107.9	18.1	758.39	-8736.57	-8736.57	-92.0	-92.0
6) Sample № 1	94.6	4.8	201.12	108.10	118.28	116.2	142.8
7) Sample № 2	111.1	21.3	892.47	730.66	751.02	451.6	531.0
8) Sample № 3	112.1	22.3	934.37	814.95	829.98	682.4	795.0
9) Sample № 4	111.3	21.5	900.85	789.39	803.42	708.2	824.6
10) Sample № 5	100.5	10.7	448.33	377.13	384.92	529.7	607.1
11) Sample № 6	110.6	20.8	871.52	670.88	696.13	334.4	396.9
12) Sample № 7	94.5	4.7	196.93	-31.07	-2.38	-13.6	-1.2
13) Sample № 8	89.2	0.0	0.00	-358.29	-313.20	-100.0	-100.0
14) Sample № 9	85.7	0.0	0.00	-200.64	-175.39	-100.0	-100.0
15) Sample № 10	104.1	14.3	599.17	527.97	535.76	741.5	844.9

Source: author's calculations.

Analyzing the coefficients of payback of organic pig fertilizer compared with bio humus "Humivit" and mineral fertilizers for example the green mass of oats (tab. 3), it should be noted that coefficient of payback of fertilizer by crop leading the ammonium nitrate (4.23 c/kg NPK) and carbamide (3.42 c/kg NPK) due to their single-component composition is actually only refers to the payback of nitrogen but Nitroamofoska as a complex mineral fertilizer has a coefficient of payback at 1.48 c/kg NPK.

Table 3. Coefficients of payback of organic pig fertilizer compared with bio humus “Humivit” and mineral fertilizers on oat example for green fodder

Variant	Coefficient of payback of fertilizer by crop, c/kg NPK	Coefficient of payback of fertilizer by conditional additional income, UAH/kg NPK	Coefficient of payback of fertilizer by conditional additional profit, UAH/kg NPK	
			Pes. variant	Opt. variant
1) Without fertilizers (control)	-	-	-	-
2) Nitroamfoska, N ₂₄ P ₂₄ K ₂₄	1.48	9.66	-11.90	-11.90
3) Ammonium nitrate, N ₂₄	4.23	20.42	-3.58	-3.58
4) Carbamide, N ₂₄	3.42	0.00	-19.89	-19.89
5) Bio humus “Humivit”	1.75	12.31	-141.86	-141.86
6) Sample № 1	1.46	3.11	1.67	1.83
7) Sample № 2	2.35	18.90	15.47	15.90
8) Sample № 3	2.23	18.58	16.21	16.51
9) Sample № 4	2.82	22.83	20.00	20.36
10) Sample № 5	2.13	9.52	8.00	8.17
11) Sample № 6	1.50	11.79	9.08	9.42
12) Sample № 7	1.67	3.47	-0.55	-0.04
13) Sample № 8	1.04	0.00	-4.18	-3.65
14) Sample № 9	1.62	0.00	-3.80	-3.32
15) Sample № 10	1.47	8.46	7.46	7.57

Source: author's calculations.

Compared with bio humus “Humivit” higher coefficients of payback of fertilizer by crop had samples number 2, 3, 4, 5, the lowest this coefficient in the sample number 8. Coefficient of payback of fertilizer by conditional additional income is highest in sample number 4 (22.83 UAH/kg NPK), ammonium nitrate is close to him (20.42 UAH/kg NPK), but by the coefficient of payback of nutrient by conditional additional profit it proved ineffective (-3.58 UAH/kg NPK), as bio humus “Humivit” (-141.86 UAH/kg NPK). Thus, by the coefficient of payback of nutrient by conditional additional profit the use of organic fertilizers sample number 2, 3, 4 is most effective; less effective – samples 5, 6 and 10, sample № 1 is the least cost effective. The use of organic fertilizer sample number 7, 8, 9 is economically inefficient. A similar conclusion can be drawn from the economic analysis coefficients of payback of costs on organic pig fertilizer compared with bio humus “Humivit” and mineral fertilizers for example oats for green fodder (tab. 4).

Consequently, the use of organic fertilizers sample number 1, 2, 3, 4, 5, 6, 10 is an economically effective, while organic fertilizers sample number 7, 8, 9 are economically inefficient. By the main indicators of economic effectiveness (coefficients

of payback, conditional additional profit, level of profitability) organic fertilizers of samples number 1, 2, 3, 4, 5, 6, 10 have significant competitive advantages over the studied brands of mineral fertilizers and bio humus “Humivit”.

Table 4. Coefficients of payback of costs on organic pig fertilizer compared with bio humus “Humivit” and mineral fertilizers on example of oats for green fodder

Variant	Coefficients of payback of costs on fertilizers by crop, c/kg NPK		Coefficients of payback of costs on fertilizers by additional income		Coefficients of payback of costs on fertilizers by additional conditional profit	
	Pes. variant	Opt. variant	Pes. variant	Opt. variant	Pes. variant	Opt. variant
1) Without fertilizers (control)	–	–	–	–	–	–
2) Nitroamofoska, N ₂₄ P ₂₄ K ₂₄	6.9	6.9	0.448	0.448	-0.552	-0.552
3) Ammonium nitrate, N ₂₄	17.6	17.6	0.851	0.851	-0.149	-0.149
4) Carbamide, N ₂₄	17.2	17.2	0.000	0.000	-1.000	-1.000
5) Bio humus “Humivit”	1.1	1.1	0.080	0.080	-0.920	-0.920
6) Sample № 1	101.7	114.2	2.162	2.428	1.162	1.428
7) Sample № 2	68.7	78.5	5.516	6.310	4.516	5.310
8) Sample № 3	93.9	107.4	7.824	8.950	6.824	7.950
9) Sample № 4	99.9	114.2	8.082	9.246	7.082	8.246
10) Sample № 5	141.1	158.5	6.297	7.071	5.297	6.071
11) Sample № 6	55.1	63.1	4.344	4.969	3.344	3.969
12) Sample № 7	41.4	47.4	0.864	0.988	-0.136	-0.012
13) Sample № 8	24.9	28.5	0.000	0.000	-1.000	-1.000
14) Sample № 9	42.7	48.9	0.000	0.000	-1.000	-1.000
15) Sample № 10	146.2	164.2	8.415	9.449	7.415	8.449

Source: author's calculations.

At the end there are calculated indicators of economic effectiveness of application of organic pig fertilizers compared with bio humus “Humivit” for the impact on potential soil fertility (tab. 5).

As expected, for the impact on potential soil fertility the bio humus “Humivit” significantly exceeds the investigated samples of organic fertilizers, but despite this, the results of comparing the cost (including the expenses for application) bio humus “Humivit” (7123 UAH/t) with the value of the newly humus (by variant I it is 797.42 UAH/t, for the second variant – 1298.18 UAH/t) indicate the excess of expenditure over the result, that the economic unreasonableness of its introduction, due to the relatively high price of bio humus “Humivit”.

Table 5. Economic indicators of the effectiveness of organic pig fertilizer and bio humus “Humivit” by impact on potential soil fertility

Variant	At the rate of 1 t of organic fertilizers			Per 1 hectare of studied culture		
	Formed humus, kg	Value of formed humus on variations, UAH		Formed humus, kg	Value of formed humus on variations, UAH	
		I	II		I	II
5) Bio humus “Humivit”	260.00	797.42	1298.18	346.58	1062.96	1730.47
6) Sample № 1	25.98	79.67	129.70	100.55	308.40	502.06
7) Sample № 2	1.61	4.95	8.05	12.49	38.29	62.34
8) Sample № 3	2.14	6.56	10.68	12.22	37.49	61.03
9) Sample № 4	2.26	6.93	11.28	12.05	36.95	60.16
10) Sample № 5	27.66	84.84	138.13	81.97	251.39	409.26
11) Sample № 6	4.61	14.14	23.02	44.26	135.76	221.01
12) Sample № 7	2.50	7.66	12.47	27.24	83.55	136.01
13) Sample № 8	0.35	1.07	1.75	5.99	18.39	29.93
14) Sample № 9	4.09	12.55	20.43	39.29	120.50	196.17
15) Sample № 10	34.93	107.13	174.40	103.50	317.42	516.75

Note. Variant I was calculated by the cost of humus 3067 UAH/t; variant II was calculated by the cost of humus 4993 UAH/t.

Source: author’s calculations.

The results of the comparative analysis of the cost price for application 1 t of organic fertilizer (optimistic version – 18.27 UAH/t, pessimistic option – 20.90 UAH/t) from with value of the newly formed humus (by variant I it ranges from 1.07 UAH to 107.13 UAH, by the second variant, it ranges from 1.75 UAH to 174.40 UAH) show results excess over expenses for the cost of humus 3067 UAH/t in samples such as number 1, 5, 10 and under the optimistic variant, and the pessimistic variant, and the cost of humus 4993 UAH/t in samples such as number 1, 5, 6, 9, 10 and the optimistic variant, and the pessimistic variant. In the case of organic fertilizers sample number 2, 3, 4, 7, 8 observed the opposite situation, which is connected with a relatively low content of organic matter. Thus, by the impact on potential soil fertility it was proven economic feasibility of organic pig fertilizer of sample number 1, 5, 10, while fertilizer sample number 2, 3, 4, 7 and 8 of this criterion were less effective, but some of them at cost of 1 t of formed humus are as bio humus “Humivit” (tab. 6).

Thus, the cost of 1 t of humus formed from “Humivit” is 27396 UAH [7123 : 0.26 = 27396], while the cost of 1 t of humus organic pig fertilizer by optimistic variant ranged from 523 UAH [18.27 : 0.03493 = 523] to 52200 UAH [18.27 : 0.00035 = 52200] and by the pessimistic option – from 598 UAH [20.90 : 0.03493 = 598] to 59714 UAH [20.90 : 0.00035 = 59714].

Table 6. Comparison of the cost of 1 t of humus that can be generated from the use of organic pig fertilizer and bio humus “Humivit”

Variant	The cost of 1 t of humus, UAH		% to the cost of bio humus “Humivit”	
	Pes. variant	Opt. variant	Pes. variant	Opt. variant
5) Bio humus “Humivit”	27 396	27 396	100.0	100.0
6) Sample № 1	703	804	2.6	2.9
7) Sample № 2	11 348	12 981	41.4	47.4
8) Sample № 3	8 537	9 766	31.2	35.6
9) Sample № 4	8 084	9 248	29.5	33.8
10) Sample № 5	661	756	2.4	2.8
11) Sample № 6	3 963	4 534	14.5	16.5
12) Sample № 7	7 308	8 360	26.7	30.5
13) Sample № 8	52 200	59 714	190.5	218.0
14) Sample № 9	4 467	5 110	16.3	18.7
15) Sample № 10	523	598	1.9	2.2

Source: author's calculations.

In a comparative context, the economic feasibility of organic fertilizers is conditioned by comparing the cost of 1 t of humus, which was the lowest in those samples organic pig fertilizer as number 1, 5, 10, it, again, clearly shows the substantial economic benefits and economic feasibility of these fertilizers by impact on potential soil fertility.

This is especially important due to the fact, that the most typical and common types of soil degradation in Ukraine are dehumification and reduction of mobile nutrients (43 % of total area), causing economic losses at agricultural enterprises (Kucher 2015).

Consequently, the use of organic pig fertilizers, except the number 8, in economic terms for the impact on potential soil fertility is more effective than bio humus “Humivit”. At the same time the obtained results determine the economic effectiveness require further research and testing in field experiments.

4. Conclusions

The estimation of effectiveness of usage of liquid organic fertilizer in the context of rational land use was conducted in Ukraine. The results of the comparative analysis of economic effectiveness of the 10 samples of organic pig fertilizer, bio humus “Humivit” and mineral fertilizers (Nitroamofoska, ammonium nitrate, carbamide) in the example of oats on the green mass show that the use of organic fertilizers sample number 1, 2, 3, 4, 5, 6, 10 is an economically effective, while organic fertilizers of sample number 7, 8, 9 are economically inefficient. By the main indicators

of economic effectiveness (coefficients of payback, conditional additional profit, level of profitability) organic fertilizers sample number 1, 2, 3, 4, 5, 6, 10 have significant competitive advantages over the studied brands of mineral fertilizers and bio humus “Humivit”. The use of organic pig fertilizers, except the sample number 8, in economic terms for the impact on potential soil fertility is more effective than bio humus “Humivit”. The most significant economic benefits for the impact on potential soil fertility are samples of organic fertilizers pig number 1, 5, 10, whose application generates the lowest cost price of humus. One of the promising ways of increasing economic effectiveness of the use of organic pig fertilizers can be to develop and test experimental control of mixes action, which may be the subject of further research.

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