ISSN: 0975-8585

Research Journal of Pharmaceutical, Biological and Chemical Sciences

Agroecological And Economic Substantiation Of Agriculture Biologization Elements.

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ABSTRACT

An intensive farming triggers mineralization of humus, which leads to a deterioration in the agrochemical, physicochemical, biological, and other properties of the soil. In this regard, the means for the biologization of agriculture should be given much more attention as a powerful means of increasing the fertility of the soil and the economic efficiency of agricultural production. The presented data testify to the positive influence of green manure crops as an element of biologization on the productivity of agricultural crops and the indices of soil fertility. In general, the most economically feasible for the crops studied is the variant of mustard embedding with the Sun Flower unit, which profitability level averaged 77.5%. While the least cost-effective was the option with the use of unembedded buckwheat - only 39.5%.

Keywords: biologization of agriculture, green manure crop, soil cultivation, economic efficiency.

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ISSN: 0975-8585

INTRODUCTION

Solving the tasks of ecological safety of modern farming systems and increasing their economic efficiency should be connected with the biology of agriculture and energy conservation, one of the main principles of which is the preservation and improvement of soil fertility through the use of organic fertilizers [4, 5, 8, 9, 15, 16, 18, 19, 20, 23], while the need for rational nature management is strengthened by the transition to sustainable development of rural areas and the "green" economy, the development of the concept of land use ecologization (3, 6.7.10).

One of the main problems of biological farming is the re-production of soil organic matter. However, a sharp decline in the production of basic organic fertilizer - manure, and the large economic costs of its introduction into the soil makes it necessary to solve this problem by involving the greatest amount of phytomass formed in agricultural crops in the biological cycle. This will make it possible to close the cycle of substances and energy in agrobiocenoses. Reforming the country's agro-industrial complex and transition to market relations has led to a significant simplification and extensification of farming systems. Many farms in order to achieve rapid economic results often do not apply scientifically based elements of farming systems. The structure of cultivated areas is violated, the crop rotation is not observed, the reserves of soil replenishment with organic matter and nutrients are not used [1, 2, 9, 11, 13, 14, 15, 18, 20, 21, 24, 25, 26].

MATERIALS AND METHODS

Field of study

The most important resource for the biologization of agriculture and enhancement of soil fertility are green manure crops, which are used as an organic fertilizer obtained from the green mass of cultivated plants and their root and stubble residues. In combination with other organic and mineral fertilizers, green fertilizer should become a powerful means of increasing yields and soil fertility.

Objects of research are: 1) soil - typical medium-heavy low-humus heavy loam black earth; 2) three types of green manure crops: white mustard, soybean and buckwheat. All the studies were carried out according to generally accepted methods.

RESULTS AND DISCUSSION

The change in the agrophysical properties of the soil and the yield of crops under the influence of the green manure crops

Soil water is the vital basis of plants, soil fauna and microflora, receiving water mainly from the soil. The intensity of the biological, chemical and physical-chemical processes that occur in it, the movement of substances and the formation of the soil profile, the water-air, nutrient and thermal regimes, and its physico-mechanical properties, that is, the most important indicators of soil fertility, depend on the water content in the soil. Consequently, soil water has a direct and indirect influence on the development and yield of plants.

The amount of productive moisture reserves in the meter layer of soil for the sowing period of corn and sunflower was influenced both by the green manure crops and the way it is dressed.

The amount of productive moisture in the undressed control sample during the sowing period was 140.9 mm.

The smallest reserves were formed when using buckwheat as a green manure crop - 132.4 mm, which is significantly higher than the experimental error (HCP_{05} = 6.3).

Various ways to dress the green manure crops contributed to the growth of this indicator. However, significant differences were noted in the control variant “Rubin"+ PLN and in mustard. The difference was 10.0 and 10.6 mm, respectively, for HCP_{05} = 8.1.

Differences in the content of productive moisture at the time of harvesting sunflower, according to different ways of embedding the green manure and among the green manure crops, were within the experience error.

The control variant of grain of corn crops accumulated 129.4 mm of productive moisture without the use of green manure crops. Approximately the same amount was in plots with mustard - 131.1 mm. The use of buckwheat and soybean as green manure crop led to a significant decrease in this indicator in comparison with the control by 8.1 and 5.5 mm, respectively (HCP_{05} = 5.2).

A similar pattern was also observed in the remaining methods of embedding the green manure crops.

Among the ways to embed the green manure crops, the variant “Rubin"+ PLN was distinguished from the control variant and the mustard by the reserves of productive moisture. The plots without green manure crops showed the indicator studied equal to 138.5 mm, which is significantly higher than the control variant - 129.4 (HCP_{05} = 7.4). The difference for mustard compared to the control variant was 9.7 mm.

By corn harvesting, the reserves of productive moisture in the meter layer of soil have significantly decreased. There were no reliable differences between the green manure crops and the ways of their embedding in the reserves of productive moisture.

The density of soil is its main, most significant physical characteristic. There is no mechanical tillage that does not have a significant effect on its density.

As the results of our studies showed, the density of soil was mainly dependent on the method of embedding the green manure crops.

It should be noted that the soil density in the 0-40 cm layer non-tilled and without green manure crops was 1.28 g/cm^3. The sowing of green manure crops led to a decrease in this indicator, but mathematically this difference is not provable. The embedment of green manure crops with the help of the "Rubin", as well as “Rubin"+ PLN and "Sun Flower” machines, led to a decrease in soil density in all variants with green manure crops. This indicator on these plots ranged from 1.19 g/cm^3 to 1.22 g/cm^3. Differences in this indicator among the green manure crops are within the error of experience.

The structure of the soil is an important indicator of the physical state of the fertile soil. It determines the favorable structure of the arable layer of the soil, its water, physical-mechanical and process properties. From the agronomical point of view, the most interesting is a fine-clad structure with a particle size of about 0.25-10 mm.

The control variant without green manure crops had maximum structural coefficient after buckwheat - 3.98, which is much higher than for control and other green manure crops. Tilling with “Rubin” resulted in no significant differences in the studied indicator among the green manure crops. The test plots tilled with “Rubin"+ PLN had their structural coefficient significantly higher after mustard and soybean than after buckwheat and on the control plot. Especially it should be noted the option with the tillage with "Sun Flower", where the soil structure for all green manure crops is lower than in the control variant, with significant differences after buckwheat and soy.

Among the ways to embed the green manure crops, the best results were obtained after “Rubin"+PLN, where the structural coefficient fluctuated within 2.9-3.79. The worst was the option “Rubin", where this indicator was at the level of 2.12-2.87.

On the average, significant differences in the soil structure among the green manure crops in 0-40 cm soil layer were established in the control variant for soybean.

Water resistance (the ability to resist the destructive action of water) of the soil structure is an important ecological property. Strong soils absorb moisture and are aerated well, easily processed, not subject to erosion.

For sunflower and corn, in the 0-10 cm layer, the amount of waterproof soil aggregates was significantly higher in the variant with mustard - 50.7, than in the control - 40.8 (HCP_{05} = 6.1). In the plots tilled with “Rubin" by tandem harrowing, mustard and buckwheat stood out significantly from the green manure crops. For other methods of green manure crop embedding, buckwheat significantly exceeded the control variant and the soybean variant in this indicator.

Among the methods of green manure crop embedding, the differences in the number of water-resistant aggregates were established on plots with mustard. For “Rubin”, the commissioned figure was 55.1%, which is much higher than for “Rubin”+ PLN and “Sun Flower”. The excess was 14.3 and 10.1%, respectively.

In the 10-20 cm layer, on the untilled variant, the variant with mustard was much superior to the control variant and the buckwheat variant for the indicator studied. This variant contained 55.8% of waterproof aggregates, which is 18.3% higher than in control and 10.3% than in buckwheat. When embedding the green manure crops with “Rubin”, mustard and buckwheat significantly exceeded the control. Among the green manure crops, soy was noticeably worse than mustard. These plots contained 43.9% of waterproof aggregates. When using "Sun Flower", soybean was the worst among the green manure crops. At the same time, the percentage of waterproofness of the aggregates in this variant was significantly inferior to the percentage of the remaining variants with green manure crops.

On the average, in the arable layer of the soil on control and on “Rubin”-tilled plots the variant with mustard should be noted, where this indicator was significantly higher among the remaining green manure crops.

The most important indicator of soil fertility is its biological activity, which determines the mobilization and immobilization of nutrients, the intensity of the cycle of substances, the sanitary state of the soil, its ability to detoxify, etc. The success of agriculture is directly related to the level of microbiological activity, which varies under the influence of various factors: in addition to the weather conditions and the type of cultivated crop, this is the content of organic matter, especially fresh, in the soil and its physical properties. These indicators are largely determined by the agrotechnical techniques that constitute the subject of this study.

In our experiment, the microbiological activity was determined by the degree of decomposition of the flax linen. Flax linens were laid on corn and sunflower for all variants of the experiment in triplicate, on July 5; the period of exposure is 1 month.

Analysis of the results of research of the intensity of decomposition of flax linen showed that the activity of soil microorganisms in the soil was influenced not only by the method of embedding the green manure crops, but also by the type of the latter. The level of cellulolytic activity of the soil decreased with increasing depth. On average, in all variants, it fluctuated: in the upper layer (0-10 cm) of soil - 7.1-15.4%, and in the 10-20 and 20-30 cm layers - 5.8-11.0% and 4.0-9.0%, respectively.

In the 0-30 cm layer, the greatest percentage of decomposition of the canvas was observed in the plots with mustard after “Rubin"+ PLN and amounted to 13.6%. The lowest percentage was also recorded after the mustard in the control variant - 8.4%.

Crop yield is the main indicator of the evaluation of the effect of all factors on cultivated crops under specific conditions. The value of the yield depends on the conditions of growth and external environment, which are related to the nature and intensity of their physiological-biochemical processes. Along with this, the technology of crop cultivation and quality of seed material matter highly.

Table 1: Sunflower yield, dt/ha

	Control	Mustard	Buckwheat	Soybean
Untilled	21.9	29.7	24.7	26.7
“Rubin”, tandem harrowing	29.3	29.6	27.6	27.3

ISSN: 0975-8585

“Rubin”+ PLN	31.7	30.6	29.2	29.1
«Sun Flower»	27.4	31.2	28.7	30.7
HCP_{05} factor A	1.3			
HCP_{05} factor B and AB 0.7	1.2			

The data in Table 1 indicate that in the untilled control variant the yield of sunflower was significantly higher for green manure crops. The differences were 2.8-7.8 dt/ha for HCP_{05} = 1.3 dt/ha. In the test plots with the green manure crops embedded with “Rubin” and “Rubin”+ PLN, the control variant and the variant with mustard significantly exceeded the variants with buckwheat and soybean. For “Sun Flower”, the maximum yield of sunflower was obtained for mustard, which is significantly higher than in control by 3.8 dt/ha and for buckwheat by 2.5 dt/ha and not significantly higher than for soybean - 0.5 (HCP_{05} 1.3).

Among the ways of embedding the green manure crops, the variant with “Rubin”+ PLN was noted in the control variant - 31.7, which is by 9.8-2.4 dt/ha more than for other methods, including control. The best variant for mustard was with "Sun Flower" - 31.2 dt/ha, for buckwheat - "Rubin"+ PLN - 29.2 dt/ha. In terms of soybean, a significant positive effect on the formation of sunflower yields was provided by deep tillage, for which the excess was 2.4-4.0 dt/ha (HCP_{05} =1.2).

The maximum yield of this crop was formed on the control variant with the use of “Rubin"+ PLN and amounted to - 31.7 dt/ha.

Table 2: Corn grain yield, dt/ha

	Control	Mustard	Buckwheat	Soybean
Untilled	51.6	55.1	53.5	51.7
“Rubin”, tandem harrowing	58.7	60.4	56.8	55.2
“Rubin”+ PLN	60.6	67.6	63.4	61.8
«Sun Flower»	58.9	63.1	62.2	59.9
HCP_{05} factor A	1.7			
HCP_{05} factor B and AB 0.7	1.5			

The data in Table 2 indicate that the yield of corn depended significantly on the factors studied in the experiment. In the control variant, where soil tillage is not provided, corn grain yield was at the level of 51.6-55.1 dt/ha. Different ways of tilling the soil contributed to a significant increase in this indicator on average by 7.1-12.5 dt/ha. In almost all variants with green manure crops, the best way of embedding was "Rubin"+ PLN, and among the green manure crops the best was mustard, which ensured corn yield in the range of 60.4-67.6. This exceeded the yield for the remaining green manure crops by 4.2-7.0 dt/ha (HCP_{05} =1.7). The maximum yield of this crop was on the variant “Rubin"+ PLN after the mustard and amounted to 67.6 dt/ha.

Economic efficiency of green manure crops

The difficult economic situation of agricultural producers and the agrarian sector as a whole necessitates the search for ways and methods of organizing production that allow for stabilization and a consistent increase in the efficiency of the agricultural sector. In this regard, the analysis of the economic situation in the industry and the development of scientifically based system of measures to improve the efficiency of agricultural production becomes urgent.

The modern stage of the development of the world civilization is characterized by the transition to an innovative model of the economy (including agrarian), which means a constant increase in the technical and technological level of production, and provides for the systematic integration of the scientific and technical sphere and the introduction of effective innovations in agro-industrial production.

The most important task of modern agricultural production is to obtain high yields of agricultural crops with a minimum production cost per unit area. Therefore, each agro-technical device should be

evaluated from the point of view of its economic feasibility, that is, the revenue received from the sale of products must cover the costs of its production, as well as ensure the receipt of additional net income. In this case, special attention should be paid to the value of profit and costs, revenue, the level of profitability of production, as well as the cost of production [17, 18, 21,].

The following is an economic analysis of the various methods of embedding three green manure crops for corn grain and sunflower - mustard, buckwheat and soybean, the results of which are given in Tables 3 and 4; variants without tilling and green manure crops are also evaluated.

First of all, it should be noted that in this experiment, the costs for variants with various green manure crops varied quite significantly: sunflower - from 30,794 rubles/ha for mustard to 31,801 rubles/ha for buckwheat; corn - from 36915 to 37,333 rubles/ha, respectively. Thus, buckwheat proved to be the costliest green manure crop, while mustard, on the contrary, required the least expenditure. The costs in control variant without green manure crops were lower - 29,215 and 35,325 rubles/ha for sunflower and corn, respectively.

As for the costs for embedding the green manure crops, they also significantly differed. The costliest in the experiment was the variant with “Rubin"+ PLN-5-35, production costs for which amounted to an average of 31,931 rubles per hectare for sunflower and 37,878 rubles per hectare for corn. The least expenditure was required for embedding the green manure crop with “Rubin” - 30,484 rubles/ha for sunflower and 36,425 rubles/ha for corn.

Table 3: Economic efficiency of green manure crops for sunflower, depending on their embedding method

Indicators	Variant			
	Control (without green manure crops)	Mustard	Buckwheat	Soybean
Untilled				
Yield, dt/ha	2.19	2.97	2.47	2.67
Sale price, rub/t	20,000	20,000	20,000	20,000
Gross output value, rub/ha	43,800	59,400	49,400	53,400
Operating costs, rub/ha	27,849	29,858	30,952	30,538
Profit, rub/ha	15,951	29,542	18,448	22,862
Prime cost, rub/t	12,716	10,053	12,531	11,437
Profitability, %	57.3	98.9	59.6	74.9
“Rubin”, tandem harrowing				
Yield, dt/ha	2.89	2.93	2.63	2.67
Sale price, rub/t	20,000	20,000	20,000	20,000
Gross output value, rub/ha	57,800	58,600	52,600	53,400
Operating costs, rub/ha	28,866	30,237	31,679	31,153
Profit, rub/ha	28,934	28,363	20,921	22,247
Prime cost, rub/t	9988	10,319	12,045	11,667
Profitability, %	100.2	93.8	66.0	71.4
“Rubin”+ PLN-5-35				
Yield, dt/ha	3.05	3.14	2.75	2.84
Sale price, rub/t	20,000	20,000	20,000	20,000
Gross output value, rub/ha	61,000	62,800	55,000	56,800
Operating costs, rub/ha	30,466	32,074	32,689	32,493
Profit, rub/ha	30,534	30,726	22,311	24,307
Prime cost, rub/t	9989	10,215	11,887	11,441
Profitability, %	100.2	95.8	68.3	74.8
«Sun Flower»				
Yield, dt/ha	2.88	3.42	3.27	2.91
Sale price, rub/t	20,000	20,000	20,000	20,000

ISSN: 0975-8585

Gross output value, rub/ha	57,600	68,400	65,400	58,200
Operating costs, rub/ha	29,679	31,007	31,884	31,539
Profit, rub/ha	27,921	37,393	33,516	26,661
Prime cost, rub/t	10,305	9066	9750	10,838
Profitability, %	94.1	120.6	105.1	84.5

In variants without green manure crops, this indicator was even lower - 29,799 and 35,162 rub/ha, respectively.

Table 4: Economic efficiency of green manure crops for corn grain, depending on their embedding method

Indicators	Variant			
	Control (without green manure crops)	Mustard	Buckwheat	Soybean
Untilled				
Yield, dt/ha	5.16	5.51	5.35	5.17
Sale price, rub/t	8000	8000	8000	8000
Gross output value, rub/ha	41,280	44,080	42,800	41,360
Operating costs, rub/ha	33,776	35,334	35,867	35,669
Profit, rub/ha	7504	8746	6933	5691
Prime cost, rub/t	6545	6413	6704	6899
Profitability, %	22.2	24.8	19.3	16.0
“Rubin”, tandem harrowing				
Yield, dt/ha	5.87	6.04	5.68	5.52
Sale price, rub/t	8000	8000	8000	8000
Gross output value, rub/ha	46,960	48,320	45,440	44,160
Operating costs, rub/ha	35,167	36,643	37,001	36,889
Profit, rub/ha	11,793	11,677	8439	7271
Prime cost, rub/t	5991	6067	6514	6683
Profitability, %	33.5	31.9	22.8	19.7
“Rubin”+ PLN-5-35				
Yield, dt/ha	6.06	6.76	6.34	6.18
Sale price, rub/t	8000	8000	8000	8000
Gross output value, rub/ha	48,480	54,080	50,720	49,440
Operating costs, rub/ha	36,432	38,148	38,561	38,369
Profit, rub/ha	12,048	15,932	12,159	11,071
Prime cost, rub/t	6012	5643	6082	6209
Profitability, %	33.1	41.8	31.5	28.9
«Sun Flower»				
Yield, dt/ha	5.89	6.31	6.22	5.99
Sale price, rub/t	8000	8000	8000	8000
Gross output value, rub/ha	47,120	50,480	49,760	47,920
Operating costs, rub/ha	35,923	37,533	37,903	37,777
Profit, rub/ha	11,197	12,947	11,857	10,143
Prime cost, rub/t	6099	5948	6094	6307
Profitability, %	31.2	34.4	31.3	26.8

The cost of gross output depended on the cultivated crop and its yield. For sunflower, it varied from 43,800 rub/ha in the untilled control up to 68,400 rub/ha in the variant with mustard embedded with "Sun Flower". For corn, this figure was significantly lower - from 41,280 rub/ha in the control variant without green manure crops up to 54,080 rub/ha for mustard embedded with “Rubin”+ PLN-5-35. Thus, this indicator varied depending on the green manure crop and the way of its embedding.

The amount of profit also varied depending on the cultivated crop, the used green manure crop and the method of its embedding. The maximum profit for sunflower was obtained in a variant with mustard embedded with “Sun Flower” machine - 37,393 rub/ha. The worst in this indicator was the untilled control, where the profit amounted to only 15,951 rub/ha.

Corn for grain in the experiment turned out to be a less profitable crop: the maximum profit was 15,932 rub/ha in the variant with mustard embedded with "Rubin"+ PLN, and the minimum - with the use of soybean without embedding - 5691 rub/ha.

Thus, the most profitable variant in the experience for sunflower was embedding mustard with "Sun Flower" machine, and for corn - embedding mustard with “Rubin"+ PLN.

Another important integrated indicator of economic efficiency is the level of profitability, which shows the percentage of the profit received as a percentage of costs.

In general, according to our experience, sunflower turned out to be more profitable for cultivation - the profitability level was 57.3-120.6%, while for corn it was much lower - 16.0-41.8%. It should also be noted that none of the variants studied was unprofitable.

In general, the most economically feasible for the crops studied is the variant of mustard embedding with the Sun Flower unit, which profitability level averaged 77.5%. While the least cost-effective was the option with the use of unembedded buckwheat - only 39.5%.

CONCLUSION

The analysis of the conducted researches shows sufficient efficiency and necessity of the further development of the biologization of agriculture.

The maximum yield of sunflower was formed in the control variant with the use of “Rubin"+ PLN and amounted to 31.7 dt/ha.

In terms of corn yield in all variants with green manure crops, the best way of embedding was "Rubin"+ PLN, and among the green manure crops the best was mustard, which ensured corn yield in the range of 60.4-67.6. This exceeded the yield for the remaining green manure crops by 4.2-7.0 dt/ha (HCP_{05} =1.7). The maximum yield of this crop was on the variant “Rubin"+ PLN after the mustard and amounted to 67.6 dt/ha.

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