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SOIL-PROTECTIVE EFFICIENCY OF INTERBRANCH OPTIMIZATION OF AGROECOSYSTEMS

The purpose. To show that optimization of the branch of agrarian production is accompanied both by localization or liquidation of separate degradation processes, in particular, erosion of soils, their dehumification and agrochemical degradation, and as a whole by heightening of ecological integrity of agricultural landscapes and economic efficiency of industrial systems. **Methods.** Field experiment, computer simulation modeling, economic-statistical analysis. **Results.** At perfecting branch structure of agroecosystems the quotient of soil-protective efficiency of terrain will be augmented in 1,5 times, sufficient balances of humus and biogenic elements will be generated, essential lowering of volumes of cargo transportations will be attained, power independence of production and heightening of its economic efficiency will be ensured. **Conclusions.** Multivariate simulation of perspective scripts of development of agricultural enterprises has displayed that its interbranch optimization will be accompanied by soil-protective perfection of agricultural landscapes' structure and reduction of degradation processes. Creation and implementation of a complex of antierosion agrotechnical

methods is applicable in the system of general long-term plan of development of agricultural production.

Key words: agroecosystem, antierosion methods, interbranch optimization agricultural production, crop rotations, localization of degradation processes, soil-protective efficiency.

Actuality. Despite the decrease in technogenic loading on agricultural territories in recent decades, a significant reduction in the intensity of agriculture, the deterioration of agricultural landscapes and the depletion of soil cover has not closed. On the contrary, because of the violation of the cycle of nutrients and energy flows in agroecosystems, the reduction of the use of organic, mineral fertilizers and chemical meliorants, the cessation of the implementation of anti-erosion measures, the threat of further loss of soil fertility, their energy potential increases [1-4].

On the other hand, solving tasks of localization and termination of individual degradation processes in agroecosystems by narrowly directed countermeasures is in many cases resource-intensive and insufficiently effective [5]. Therefore, the problem of stabilizing of the ecological state of individual production systems and regions in general must be solved in a complex way by means of balanced improvement of the structure of agro-landscapes, in particular through cross-sectoral optimization of agrarian production [6]. Thus, it is unnecessary to grow fodder crops, in particular perennial bean grasses, which leads to a reduction in their share in the structure of crops area with a corresponding increase in the proportion of grains and growing crops. This, in turn, is accompanied by an increase in various negative processes, in particular, dehumidification, agrochemical degradation, wind and water erosion. With cattle-breeding available feed legumes, not only provide a complete feeding of cattle, but are a powerful factor in achieving ecological balance in agroecosystems. For example, legume grass for environmental impact, in particular on anti-erosion resistance of soil, is equal to natural herbal phytocenoses, for long-term cultivation of them in on allocated fields which make 20-25 % of land use considerable improvement of structure of agro-landscape it achieved [7]. In addition, for every tone of dry matter of yield of the green mass of legumes perennial grasses 25-30 kg of biological nitrogen is accumulated in soil [8]. That is, cross-industry optimization of agrarian production can largely determine the environmental sustainability and balance of rural areas, in particular by minimizing the intensity of erosion processes.

The purpose of research. To establish the possibilities of localization of degradation processes through inter-sectoral optimization, increase of the level of use of biological factors, increase of biogenic elements recycling and economic indicators by comparative analysis of perspective scenarios of agrarian production development on the example of economic activity typical for Northern Step of agricultural enterprise

Method. The work was carried out through multivariate computer simulation using a special software complex, which in operative mode enables to develop various scenarios for the development of agrarian production in relation to the specific conditions of land use [9]. The advantage of this methodology is that changes in one of the parameters of the agricultural activity of an agricultural enterprise can be analyzed through changing of other ones. In this case, there is no need in conducting a full-scale experiment, which is associated with high risks of negative consequences or even destruction of the system and is typical for traditional methods of decision-making based on practical experience and intuition.

Different perspective scenarios were developed for the development of the agricultural enterprise Slavutich LLC in Pokrovsky district of the Dnipropetrovsk region with an area of arable land of 3788,7 hectares. In order to assess the expediency and to determine the peculiarities of the expected positive results of modeling on a larger area, the option of combining of above mentioned enterprise with the neighboring LLC "Bogdan" with the arable land of 2534,6 hectares was considered. In the simulation, the information base of the stationary experiment of the former Zaporizhzhya research station was used [10]. For promising Models № 3-5, productivity of crop rotation in the variant of organo-mineral fertilizer system is - 45-55 hundredweight of feed units (f.un.)/ha, depending on the share of individual crops. The number of cattle was modeled from the initial density - 0,23 conditional cattles (c/c) /ha to 0,5 and 1c.c./ha. The productivity of dairy cows was taken at the level of 4 thousand kg of milk per year.

Results. 5 Models of development of "Slavutich" LLC and Bogdan LLC were considered:

For Model № 1 - the initial state with a load of cattle 23 c.c. per 100 hectares of arable land, the productivity of plant growing is taken as the average for the last years within the LLC Slavutych – 34,2 centners f.un./ ha with the unsystematic placement of crops in fields and outlines.

Model № 2 - animal husbandry - 23 c.c. per 100 hectares, plant productivity at the level of Model № 1 – 34,2 hundredweight f.un./ ha with the formation of new crop rotation. It is considered for comparison with the previous and establishment of efficiency of ordering system of crop rotation.

Model № 3 - is considered for the purpose of evaluating the expediency of increasing the number of animals to 50 c.c. per 100 hectares of arable land.

Model № 4 - is considered to assess the expediency of increasing the number of animals to 100 c.c. per 100 hectares.

Model № 5 is considered with the aim of assessing the expediency of increasing the area of land use from 3788,7 to 6323,3 hectares for the density of animals 100 c.c. per 100 hectares of arable land.

Ensuring full feeding of animals requires the creation of a feed base corresponding to the livestock population, which in turn is determined by the need for various types of forage, which grows from 3,2 thousand tons f.un. on Models № 1 and № 2 up to 24,2 thousand tons f.un. according to the Model № 5.

For effective planning of obtaining such amount of feed by species, a program of production of roughage, juicy and green fodder, as well as a green conveyor, is developed. The sown area of individual feed crops was determined through yields - the average for the enterprise for 5 years (Models № 1 and № 2), or the average long-term obtained from the background of the organo-mineral fertilizer system in the stationary experiment.

Determination of the area of cropping of forage crops makes it possible to plan the general structure of the sown area in the Models, which is determined by the priorities of zonal specialization [11]. From Table 1 it can be seen that as the number of animals grows, the area of perennial grasses will increase from the original 143 ha to 1300 ha which is a subject to the introduction of a promising Model № 5. On the basis of the obtained structure of the crop area, models of crop rotation are developed based on the following principles:

• best precursors;

• optimization of volumes of cargo transportation;

• increased reproduction of soil fertility at the minimum cost of industrial resources with maximum use of biological factors;

• Flexibility - the possibility, without violating the introduced crop rotation, to significantly increase the specific weight of individual crops of the specific conditions of the individual years;

• the maximum possible size of the fields.

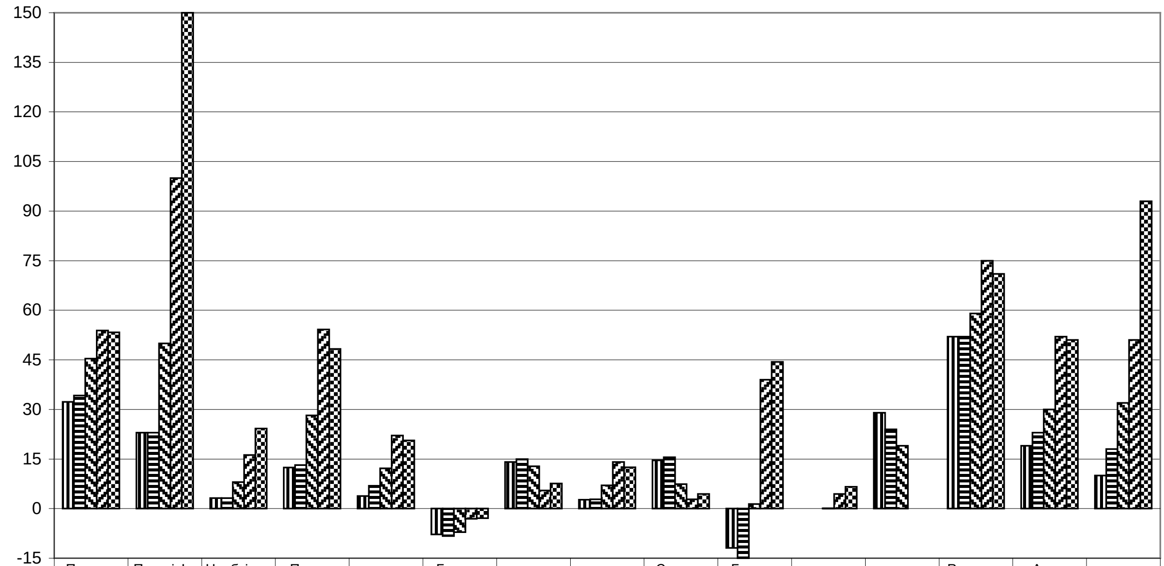
According to the scenario Model № 2 grain and grass crop rotation (1, 2 - perennial grasses - yielding fields, 3 - winter wheat, 4 - corn for grain ½ + sunflower ½, 5 - peas ½ + annual grasses ½) is formed from the most distant from economic courtyard of land contours, and the average size of the field corresponds to an area that provides for the cultivation of a sufficient number of perennial grasses in the hay and haulage. The balance of humus is regulated at the expense of plant residues of perennial grasses and by-products of crop production for fertilizers. Feed crop rotation (1 - perennial grasses (VP), 2 - winter wheat, 3 - corn silage, 4 – corn on silo; 5 - winter wheat; 6 - corn on silage; 7 on winter on g/f, corn on g/f) is designed to meet the needs of the green conveyor, the preparation of corn silage and placed directly on the land adjacent to the dairy farms for the stable provision of animals with green and juicy fodder with minimal transport costs The rest of the contours are allocated under 7 - free field grain beet crop rotation (1 - winter wheat, 2 - sugar beet, 3 - soybeans, peas, cereals, 4 - winter wheat, barley, 5 - corn for grain, 6 - sunflower; 7 - black pairs). Implementation of such a crop rotation system in comparison with the initial provisions allows to reduce volumes of cargo transportation by more than 50 thousand t / km (Table 1).

1. Comparative volumes of inland cargo transportation at the actual placement of crops (Model № 1) and the introduction of new crop rotations (Model № 2), t/ km

Indicator	New crop rotations				Initial placement	Saving (-), т/км
	feed	field	grain-grasses	total		
Distance to the field, kм	1,8	6,9	10	–	6,8	–
Winter wheat	447	20980	9000	30427	38488	-8061
Barley	–	–	–	–	14477	-14477
Pea	–		–	–	3433	-3433
Corn for grain	–	13110	7000	20110	15232	4848
Sugar beet	–	78660	–	78660	60928	17732
Soy bean	–	3935	–	3935	7310	-3375
Sunflower	–	5245	2000	7245	10832	-3587
Corn g/f, for silage	4320	–	–	4320	16440	-12663
Buckwheat	–	–	1100	1100	–	1100
Annual grasses	1722	–	–	1722	3777	-2055
Perennial grasses	447	–	9000	9447	25650	-16203
Manure	4320	55200	–	59520	70856	-11336
Total	11256	177130	28100	216486	267423	-51510

In the framework of LLC "Slavutich" the livestock can be brought up to 1,5 c.c. per hectare, provided that the lands of LLC Bogdan are brought in. In this case, in accordance with Model № 5, the area of LLC "Bogdan" should be used as a remote grain-grass crop rotation № 2, and the land of LLC "Slavutich" - in accordance with Model 2.

The given Models and crop rotations are not necessarily the final option for their implementation. However, their analysis (Figure 1) on the part of the management provides an opportunity to objectively assess the benefits of adapting the sectoral structure to the agro-resource potential of the enterprise, in particular from the point of view of increasing the stability of land use to degradation processes. Comprehensive assessment of the developed models allows management personnel to understand the internal laws of the functioning of the production system, identify unused opportunities and adjust the development plan taking into account specific factors and constraints. After the formation of a prospective plan for the modernization of the enterprise, the transition tables are made up: in crop production - from the initial placement of crops by fields and contours to the planned crop rotation system, in livestock production - from the actual population of animals to the planned species structure, the numerical and genetic composition of the herd, in mechanization - from the actual provision of means of mechanization to optimal, etc.



	Продук-тивність, ц к.о./га	Поголів'я, у.г. на 100 га	Необхідно кормів, тис т	Площа кормових, %	в т.ч. трав, %	Баланс гумуса, ц/га	Необхідно гною, т/га	Наявно гною, т/га	Солома добриво, тис. т	Баланс оргдоб-рив, тис. т	Газ-метан, млн м3	Потреба у NPK, кг/га	Рецирку-ляція NPK, %	Азот-фіксація, кг/га	Дохід, млн грн
Модель №1	32,3	23	3,2	12,4	3,8	-7,8	14,1	2,7	14,6	-11,9	0	29	52	19	10
Модель №2	34,2	23	3,2	13,2	6,9	-8,3	15	2,8	15,5	-15	0	24	52	23	18
Модель №3	45,4	50	8	28,2	12,2	-7,1	12,8	7	7,4	1,4	0,1	19	59	30	32
Модель №4	53,9	100	16,2	54,2	22,1	-3,1	5,5	14,1	2,8	39	4,4	0	75	52	51
Модель №5	53,3	150	24,2	48,3	20,6	-2,9	7,6	12,5	4,4	44,4	6,6	0	71	51	93

Fig. 1. Parameters of models of production activities of LLC Slavutich and LLC Bogdan (revenue - at prices in 2014)

The results of the research indicate that the formation of a complex of measures on the localization of degradation processes in the agroecosystem, in particular soil erosion (Table 2), should be carried out after optimization of the agro-landscape structure, which is mostly achieved through the activation of biological factors and the use of soil protection action of perennial herbs. And on this basis, it is expedient to elaborate the final system of anti-erosion agrotechnical measures on the specific conditions of land use.

For example, deepening of the soil by 10-15 cm is associated with the additional costs of PMM. At the same time, the prolonged cultivation of perennial grasses in the field of yield (3-4 years) is not related to the cost of fuel in general and differs by significantly higher ground-protection efficiency (see Table 3). As a result, the use of soil protective processes can be minimized with a significant increase in agroecosystem stability to degradation processes, in particular water erosion, dehumidification and depletion of land.

2. Coefficients of soil protection efficiency of agrotechnical anti-erosion measures and agrofons of relatively pure steam [8]

Agrotechnical factors	Coefficients of soil protection efficiency
Nude surface of the soil - pure steam	1
Growing crops (sat down horizontally)	1,6
Spring cereals	4
Winter cereals	5
Annual grasses	10
Perennial grasses	20
Stems of winter cereals	3
Stems of cereals - bean mixture	2,5
Stems of pea	1,6

Extrusion at depths up to 60 cm according to the scheme of 1 + 5 m	2
Sowing buffer strips for a couple of widths 7,2 m by 50-60 cm with cleavage along the edges of the stripes	3
Gutting in the tracks of the tractor wheels at the same time the submergence of plants of cultivated plants	2
Deepening of the soil by 10-15 cm with the plowed pawns, which are installed through one housing	2
Deep moldboard ploughs basic cultivation	2

Thus, as a result of the improvement of the sectoral structure of LLC Slavutich and LLC Bogdan, the coefficients of soil protection of the territory of land use will be increasing from 4,1 to 6,6 or by 1,5 times, the biological fixation of nitrogen will increase from 20 to 50 kg / ha. Due to biological nitrogen, as well as an increase in the recycling of macro- and trace elements with organic fertilizers to 70-75%, a neutral level of agrochemical land degradation is achieved and enhanced reproduction of the soil's humus soil is ensured. This situation, in turn, will in the long run allow to switch to the principles of organic farming and production. From the point of view of economic efficiency, implementation of perspective business development scenarios in the enterprise will increase profitability from 2,6 thousand UAH / ha (Model 1) to 13,5 thousand UAH / ha (Model № 4), and for extension of land use - up to 14,7 thousand UAH / ha.

Conclusions The soil protection improvement of the agro-landscape structure is carried out through a comprehensive multisectoral optimization of agrarian production. Solving this problem is achieved by using multivariate computer simulations. Creation and application of a complex of soil protection agrotechnical measures is expedient to implement in the system of the general plan of the development of agricultural enterprises, the realization of which in practice does ensure high ecological sustainability and economic efficiency of agroecosystems.

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