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Spatial optimization of agricultural land

Purpose. To substantiate the statement of the problem of optimal distribution of the structure of agricultural lands between administrative districts on the example of the Kharkiv region in order to achieve maximum yields due to the use of arable land of varying degrees of erosion. Methods. Linear programming, mathematical-statistical analysis. Results The methodical approach to the ecological and economic optimization of the agricultural land structure at the regional territorial level is proposed, which simultaneously takes into account the economic feasibility of using arable land and ecological requirements for the preservation of soil fertility. The algorithm of such optimization is substantiated and its results for the Kharkiv region are presented. Conclusions Spatial optimization of the agricultural land structure is an important tool for improving the use of land resources. The developed methodological approach allows us to take into account the economic and environmental components of such optimization. It is expedient to use it to make managerial decisions when substantiating regional programs for rational use and protection of land.

Key words: agricultural lands, structure, spatial optimization, arable land, protection of soils.

Relevance of research. The structure of agricultural land is an important lever in balancing anthropogenic land load with a view to the most rational use of agricultural land. Therefore, ecological and economic optimization of land and crop rotation is a key task of modern land management. However, until now, the solution to such problems remains problematic due to the contradictory nature of the requirements of cost-effective use and conservation of soils. Therefore, it is advisable to develop an algorithmic approach to the implementation of the specified optimization. Analysis of recent research and publications. In modern conditions of land use, the problem of preventing soil degradation becomes particularly acute [2, 3]. To perform zaznacheno¬ho in Article 3 of the Law "On Land Protection" [3] the principle of normalization and systematic obmezhen¬nya impact of economic activities on land need to prove scientifically maxi-mally permissible arable land at the national, regional and local administrative te¬rytorialnyh Levels. The most effective zakh-lady for the protection of land are considered organizational [4]. According to the program "Grain of Ukraine 2015" in Ukraine it is proposed to withdraw from the active cultivation of more than 8 million hectares of arable land [8]. Unfortunately, there are still no convincing criteria for soil protection of land. In methodical recommendations [6] for the purpose of soil protection of crop rotation is proposed the withdrawal from the warehouse of arable land with an angle of inclination of more than 7o. This restriction is important, but insufficient for soil protection optimization of agricultural lands. M. Kotter, co-author of the study of the possibilities of planning land-use land-use on the basis of a combination of environmental assessments and economic optimization, developed a model based on linear programming, implemented using the GAMS modeling system. With this mo¬deli attempt to integrate environmental constraints and economic benefits in a single syste¬mu decision-optimized zemleko rystuvannya within the catchment area of the river Naban subregion Greater Mekong to 2025 [11]. Ksioli Lee Jung Chen, Lee Daolianh based on GIS technologies developed support system management decisions aimed at Optima tion patterns of land use, which includes: Geographic Information System (GIS), land-use modules, user interface tools and land use planning. The functioning of the system is based on linear programming and non-clear clustering algorithms implemented on the platform of ArcEngine software [13]. Jung-Feng Gao Cheng-Feng Li, Hong Hu Chzhanh developed a system to optimize the structure of land-based sil¬skohospodarskyh achieve the highest possible income for the Jiangsu Province of China, which allows for using GIS spatial distribution of nutrients in ŕrun¬tah incline and exposure Relief, the nature of land use and other factors. A certain disadvantage of such an optimization is that it does not take into account the ecological component of land-use [12]. Known methodical approach to the optimization of the structure of soil sys¬temnoyi farmland [5] provides algorithmic optimization ratio and distribution of agricultural land der¬zhavnomu and regional space-ing detail, but takes into account its economic component. It is proved that losses from reducing yields due to reduced fertility of eroded soils reach significant sizes [10]. The purpose of the research is to substantiate the universal methodical approach to the integrated spatial optimization of the structure of agricultural land in the administrative area. Determine the optimal areas of arable land for administrative districts of the Kharkiv region. Research methods. Linear programming, mathematical-statistical analysis. Research results. Consider the provision of a comprehensive spatial optimization of the agricultural land structure at the regional level as a statement of the distribution problem of optimization. The most acceptable is an algorithm that involves differentiated consideration of the influence of eroded soils on soil fertility and a comprehensive ecological and economic approach to the solution of the problem. The objective function of this task is the minimum general probability of erosion and the maximum use of natural fertility of soils as a result of the division of the defined area for the agricultural lands between the regions. For ease of setting the problem in the 1st row of the matrix, we will determine the arable land, in the 2nd - the long-term plantations, and in the 3rd - the hayfields and pastures. Let y ^ - average yield of grains on non-eroded lands; - Average grain yield in the administrative area j. Calculated based on data table. 1 conversion factors yields on eroded soils neerodovanyh on average for grain have the zna¬chennya: slaboerodovanyh for soil - 0.83, serednoerodovanyh - 0.51, sylnoerodo-emyh - 0.29. Taking into account the coefficients of Table. 1, the average yield of grains associated with harvests-tion on soils of varying degrees of erosivity can be determined by the formula (1) de nos; - Average yield of cereals in the administrative region and, c / ha; - yield of grains on non-eroded lands, c / ha; P1 - p4 - fractions of arable land in the region of the corresponding degree of erodibility (p1 - non-eroded, p2 - weakly eroded, p3 - medium-grained, p4 - strong-formed); Un - yield of grains on non-eroded lands. Hence, the yield of grains on non-eroded lands can be calculated from the following formula: Probably, the degree of soil erosion is directly proportional to the risk of erosion, and rational use of land resources needs to reduce this risk. Consequently, the maximum possible involvement of non-aerated and low-eroded lands in the arable land, on the one hand, reduces the overall risk of erosion, on the other hand, makes it possible to make the most of the natural fertility of soils in agriculture. The objective function of the ecological-economic optimization of the spatial distribution of agricultural land within the administrative districts of the oblast is as follows: (3) where Itakh is the maximum grain yield, Ts / ha; X1i - the area of arable land within the administrative district and, ha. Other symbols remained unchanged. The meaning of the objective function (3) is to maximally involve the arable lands with the highest bonitete, which are at the same time the least eroded. Limitations of the task are: (4) (5) (6) (7) (8) (9) de Hu is the area of the i-th land within the i-th district, ha; Bi is the area of the i-th land within the region, ha; B - area of agricultural land in the regions of the i-th district, ha; B - the area of agricultural lands within the administrative boundaries, ha; X2u is the area of perennial plantations within the i-th district, ha; X3y - area of pasture and grasslands within the i-th area, ha; Rhythm - the maximum share of areas of pastures and grasslands in the areas of the districts (for the Kharkiv region - 0,07). The constraints (4) - (7) are necessary constituents of the set distribution problem of the closed type. The limitation (8) is due to the fact that the areas of perennial plantings do not actually change in time [1, 9]. Restrictions (9) have been introduced for environmental reasons. Incoming information for optimizing the lands of Kharkiv region is given in the table. 2. The average yield of grain was calculated according to the statistical data for 1995 - 2011 [9]. The structure of agricultural land of the Kharkiv region. Determined by the decision of the optimization task at the state level - for extensive (E = 1081413 hectares) and intensive (E = 1927000 hectares) soil protection scenarios from erosion [5]. The result of the optimal distribution of the arable land area of the Kharkiv region is determined. Between rations in the two mentioned variants (Table 3). The actual areas of arable land are presented as of 2011 [9]. Extensive scenario of soil protection prevents erosion by attracting exclusively erosionally safe lands to the arable land, intensive - due to the adherence of erosionally safe crop rotation to prevent erosion of existing arable land. In the intensive scenario, the maximum permissible coefficient of erosion hazard of arable land for the Kharkiv region is 0.34, which corresponds to the soil protection effect of winter wheat [7]. Extensive soil protection scenario requires the removal of large areas of greenland from the arable land (37-48% of the available). In Balakliya, Blyznyuk, Vovchansk and Lozova districts, such planes will amount to over 46,000 hectares. An intensive scenario for solving the problem of soil protection from erosion is also little realistic due to the economic impossibility of artificially achieving the necessary soil protection efficiency of crop rotation. Therefore, in the future, based on the proposed methodological approach, it is necessary to find a more or less balanced solution, which depends on the planned crop yields for the region.

1. The coefficients of conversion of yield on eroded soils on non-eroded [10]
2. Average yields of Kharkiv region.
3. optimal distribution of arable land between districts of Kharkiv region.

Conclusions

Spatial optimization of the structure of agricultural land is an important means to increase the efficiency of land use. The developed methodological approach allows us to take into account the economic and environmental components of such optimization. Since the problem of optimizing the structure of agricultural lands has been approved as one of the important conditions for the sustainable development of agriculture in Ukraine at the level of land legislation, it makes sense to use a universal algorithm for its solution. For optimal use of agro-resource potential of Kharkiv region. It is expedient to transform the structure of arable land by area. The proposed approach should be used when justifying regional programs of rational use and protection of land.

Bibliography

1. FAO Database [Electronic Resource]. - Access mode: http://faostat3.fao.org/home/index. MtI # 0O \ LMoya.

2. Law of Ukraine "On the Protection of Land" // Uryadovy Courier. - 2003. - № 144.

3. Land Code of Ukraine // Village time. - 2001. - No. 66 (268).

4. Kanash O.P. Ecological views on certain economical problems of land use / O.P. Kanash // Land management and cadastre. - 2006. - No. 1. - P. 32 - 34.

5. Kutsenko M.V. Soil protection optimization of agricultural land structure / M.V. Kutsenko, O.V. Kruglov // Visn. Agrarian science. - 2014. - No. 1. - S. 51 -54.

6. Methodical recommendations for the development of land management projects that ensure the ecological and economic ordering of crop rotation and land management // Land management wis. - 2013. - № 10. - S. 52 -63.

7. Morgun F.T. Soil-protecting agriculture / Ф.T. Morgun, NK Shikula, AG Tarariko - K.: Harvest, 1988 - 256 pp.

8. The Grain of Ukraine 2015 program. - K .: DIA, 2011. - 48 p.

9. Kharkiv region in 2011: Statistical Yearbook / State Statistics Committee of Ukraine, Main Department of Statistics in Kharkiv. Region - X .: Heads. Exercise Statistics in Kharkiv. Region - 2012. - 1 o = ea Wholesale CD (CD-ROM). - bc

10. Ecological and economic problems of agricultural production; Ed. O.F. Ba-lak. - K.: Harvest, 1992. - 144 p.

11. Designing a Sustainable Land Use Scenario Based on A Combination of Ecological Assessments and Economic Optimization / M. Cottera, K. Berkhoff, T. Gibreel et al. //Ecological Indicators. - 2014. - V. 36. - R. 779 - 787.

12. Jun-feng Gao. Soil spatial analysis and agricultural land use optimization using GIS / Jun-feng Gao, Chang-feng Li, Hong-hui Zhang // Chinese Geographical Science. - 2003. - V. 13, Iss. 1. - P. 25-29.

13. Xiaoli Li. A Spatial Decision Support System for Land-Use Structure Optimization / Xiaoli Li, Yingyi Chen, Daoliang Li // J. WSEAS TRANSACTIONS is COMPUTERS. - 2009. - V. 8, Iss. 3. P. 439-448.

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