

**IMPROVING THE SPATIAL DISTRIBUTION OF THE AGRO-INDUSTRIAL COMPLEX (AIC) PRODUCTIVE FORCES IN THE TRANSNISTRIA REGION AS THE MOST IMPORTANT CONDITION FOR ITS SUSTAINABLE DEVELOPMENT**

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**Abstract**

*Successful social and economic development always serves as the main task of both a single economic entity and the state as a whole. This requires continuous scientific research of internal and external development factors. This task is of particular importance in the context of fundamental transformations in the economy as a whole and especially in the agro-industrial complex (AIC). Fragmentation of the main means of production (land) between small users, and the incompleteness of transformation of ownership relations in the rural environment negatively affect the efficiency of its use, the socio-economic development of both individual regions and the state as a whole. The paper discusses the current state and development options of the regional AIC and highlights lags in the scientific development of methodological and applied aspects of its reform. The issue of spatial distribution of AIC productive forces is of special importance in this context.*

*The paper proposes an economic and mathematical spatial/transport optimization model for the productive forces of AIC in the region.*

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**Keywords:** *land resources, agro-industrial complex, sectoral structure, spatial distribution of the productive forces, supply and marketing logistics*

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## **1. Introduction**

Fundamental political and economic changes took place in the post-Soviet space at the end of the XX century. The unified economic mechanism has ceased to exist, the ownership relations undergone transformation. The unified economic mechanism has broken up into many independent economic regions. Significant changes have occurred in the regional AIC. Collective agricultural organizations (collective farms) were winded up, while progress in the formation of new management forms is extremely slow. At the same time, there is a lack of scientific support for the reform of this most important industry of the region; this leads to inefficient use of land resources, inefficient structure of this industry, and an imbalance between the raw material base and production capacities of the food industry. This may affect the food security of the region.

These changes highlighted the problem of developing a new model of spatial distribution of the productive forces, as one of the most important factors in increasing the efficiency of AIC functioning, and the socio-economic development of the regions as a whole.

## **2. The degree of current investigation of the problem, the purpose of research**

The scientific theory of the spatial development of regions goes back to the mercantilists. They focused on foreign trade and relations between states, isolated in the territorial sense. A significant contribution to economic research was made by physiocrats who analyzed the territorial contradictions between the city and the village [2, pp. 147-149].

The spatial division of labor was paid much attention in the classical economic theory. Adam Smith attached decisive importance to the absolute costs of production. David Ricardo proposed the law of comparative costs – a country must produce and export goods that are relatively cheaper for it, and import those goods which production abroad requires fewer costs than domestically.

Governments in the countries with market economy focus on ensuring economic growth, full employment, price stability and the balance of foreign economic activity.

These most important public goals cannot be achieved without taking into account the spatial development of production. In 1909, the German economist Alfred Weber published his famous “Theory of the Location of Industries” with an analysis of production location factors, and proposed methods for determining the location of production using isodapanes, that is, lines of equal transport costs per unit of output [3, pp. 97-99].

Experts recognize the great contribution of A. Weber to the formation of the theory of production location in general, but are practically unanimous in assessing the weaknesses of his theoretical concept [4, pp. 146-155]. A serious drawback was the justification of the choice for a production unit placement based on the lowest production costs, while in reality the decisive role in placement is played by the profit. The main Weber’s bias was his approach to the problem of location from the standpoint of a single production unit.

August Lösch and other researchers of this problem went further, they began to study the problems of production and industries location within various territorial entities (cities, districts, regions), as well as the development of methods for spatial analysis within an industry and intersectoral relationships in the economy as a whole.

Researchers and practitioners consider the “The Economics of Location” by Lösch as the classic theory of production placement [6, pp. 78-117]. The author fundamentally revises the methodology for choosing the production unit location, described in the works of Weber and some of his predecessors. He concludes that neither total costs nor gross revenues, not to mention their individual elements, make such a choice possible. During the analysis, each of these indicators is considered separately, however, the final and only factor determining the choice of place will be their result – net profit.

Alfred Marshall, the founder of the neoclassical approach to spatial problems of the economy, examined in detail in his work “Principles of Economics” the regional aspect of the

organization of production and analyzed the causes of the emergence of localized industries [7, vol. 1, p. 349], draws attention to the negative results of territorial concentration and indicates ways to eliminate them [7, vol. 1, p. 353].

In the Soviet period, Moldavia accumulated positive experience of the spatial organization of economic activity of the agro-industrial complex (AIC) on a scientific basis [1, pp. 228-354]. However, the transition to a market economy and the reform of forms of ownership pose new challenges for the scientific community and business to ensure the effective functioning of the most important sector in the new conditions [5, pp. 194-237].

The aim of this work is to study the current state of the regional AIC and develop a mathematical economic production and transportation model for optimizing development and location of its productive forces.

### **3. Applied methods and materials**

In this study we used the following: statistical observation, analysis, generalization, methodological approach to research and development of proposals for improving the spatial distribution of the productive forces of the agro-industrial complex (AIC) in the region.

The materials of this study are regional statistical data on the agro-industrial complex for the period 2000-2018.

Studies of regional problems of economic regions are of particular interest. This is especially true in the current period when the supply and marketing logistics of earlier created enterprises changed dramatically as a result of the collapse of the unified economic mechanism and the emergence of new economic entities.

Given the agrarian orientation of the region's economy, decisions on the spatial distribution of production should be based on regional natural and human resources, climate, infrastructure, proximity to the sales market (consumer). At first glance, this approach may turn out to be erroneous in terms of well-known shortcomings in the quality of the labor market if the work operations on it are predominantly uniform (agricultural workers). However, the elimination of this drawback consists in the development of additional industries in the same field: agricultural engineering, processing industry, poultry and livestock farming, construction industry, and long-term storage facilities for raw materials.

Given the historical geographical location of rural settlements in the region, as well as the fragmentation of land resources among small and medium producers, an extremely difficult problem arises: ensuring the efficient use of available land resources, preserving and developing unique settlements with their social infrastructure.

For the region, this should be the most important public task.

Taking into account the new land issues (state ownership of land, division of land into shares), it is necessary to solve the problem in terms of creating economic structures and optimizing their spatial distribution, without which it is unthinkable to address the issues of efficient use of land resources, as well as the issues of socio-economic development of both rural settlements with their infrastructure, and the state as a whole.

We believe that in order to overcome the current negative situation in the agricultural sector it is fundamentally important to solve several key tasks.

The primary and, in our opinion, the main thing should be the creation of major raw material bases by:

- concentrating land in modern economic organizations (LLC, OJSC, cooperatives, partnerships, national enterprises, etc.)
- gradual synthesis of agriculture with the processing industry and thus the creation of a continuous process of growing raw materials, their processing and production of finished consumer products;
- developing mutually beneficial industrial and economic relations between participants in a unified agro-industrial system;
- integrating science and production, direct participation of scientists in solving practical problems of developing the most important industry for the region.

The development of this economic direction will require the development of other related sectors typical for agricultural regions, and, consequently, a more advanced sectoral structure of the economy based on national resources. Also, the structure of the foreign trade balance will be improved, namely, the exports of agricultural raw materials and their processing products will increase significantly. The revival of the agro-industrial complex of the republic on the basis of organizational transformations will be the beginning of positive changes in the demographic situation, the restoration of rural settlements, the increase in rural incomes, the reduction of state subsidies to rural residents from the budget, without reducing their standards of living, since they will have more job opportunities.

In our opinion, the existing administrative and territorial structure of the region, and transport and water infrastructure allow us to build an economically and socially more favorable territorial deployment of the productive forces. It should be based on:

- the soil and climatic conditions of the regions;
- the availability of labor resources and their consolidation in the historically established territorial structure;
- and the revision of the existing territorial distribution of food industry enterprises.

The region, as an economic entity, has a unique geographical location. On the one hand, there is an international highway running through the whole territory; the western border is washed by the Dniester River. This creates favorable conditions for economic development and external economic relations.

On the other hand, there are certain difficulties for the deployment of productive forces. This is mainly due to the peculiarity of the territory itself – 202 km from north to south and 40 km from west to east.

During the period of the former geographical distribution and the unified economic mechanism of the USSR and Moldavian SSR, economic decisions on the deployment of productive forces were taken with account these factors.

#### 4. Obtained results and discussions

In the current geographical and economic borders, given the fragmentation of land among small users and their right to choose the types of activities, the supply and marketing logistics of the AIC productive forces is extremely inefficient. This led to the liquidation of such large enterprises as: Canning plant (Grigoriopol), Meat processing plant (Rybnitsa), Dairy plant (Rybnitsa) [9]. Surviving food industry enterprises use their production capacity by 30-40% due to the difficulties with supply of raw materials, while ensuring their operation entails significant unproductive transportation costs, which increases the cost of production, and, accordingly, retail prices for socially significant products. The radius of areas for the delivery of raw materials to production sites and delivery of finished products to consumers increases by 3-5 times. Excessive load on the road infrastructure leads to its premature destruction, and, consequently, additional budgetary costs to repair them.

This situation negatively affected the industry structure of AIC (Table 1).

**Table1. Agricultural production for 2000-2018**

Product	2000	2014	2018	2018 to 2000, %	2018 to 2014, %
Cereals and legumes, tons	135600	368966	405723	299.21	109.96
Sunflower, tons	36500	69522	93415	255.93	134.37
Potato, tons	400	6854	1910	477.50	27.87
Open ground vegetables, tons	32500	32749	27737	85.34	84.70
Fruits and berries, tons	8300	9082	16985	204.64	187.02
Grapes, tons	8200	24669	23048	281.07	93.43
Cow milk, tons	21600	7185	6767	31.33	94.18
Chicken eggs, thousand pcs.	2200	31787	172	7.82	0.54
Vegetable oil, thousand tons	8.8	0	0.083	0.94	0.00
Flour, thousand tons	51.2	0	31.7	61.91	0.00
Canned food, mln. cans	43.9	4.45	7.86	17.90	176.63
Sugar, thousand tons	0	0	0	-	-

Source: developed by authors of [9]

The data presented in Table 1 illustrate the extent of the impact of the existing problems in the regional AIC on the structure of agriculture. The region, which was the main producer of sugar, vegetables and canned vegetables in the 20th century, now significantly has reduced the production of these products. For example, sugar production is completely stopped; the production of canned vegetables decreased by 5.6 times, the production of vegetable oil decreased by more than 10 times. The main reason for this is the discrepancy between the existing spatial distribution of the AIC productive forces and the new business environment.

Thus, we cannot call effective the distribution of productive forces inherited by the region, the slowness of the reform of these forces in terms of economic and social efficiency, which implies the impact of the distribution of productive forces on the demographic situation, the preservation and development of rural settlements, health care, education, culture in the current economic conditions.

Taking into account all the above mentioned, the government should take control over the development of the general layout of productive forces, with account of the current administrative borders and territorial features of the region.

Determination of the best option for the development, specialization and distribution of production, which will ensure a minimum of total reduced costs while meeting the needs for the products, should be done using mathematical economic methods.

To calculate the optimization of the development and location of productive forces the following mathematical economic production-transport model is proposed.

The following notation will be used below:

$i$  – index of product manufacturing point  $i=1, 2, \dots, a$ ;

$p$  – number of product manufacturing points;

$j$  – index of product consumption point,  $j=1, 2, \dots, n$ ;

$n$  – number of product consumption points,

$m_i$  – capacity option index at the  $i$ -th manufacturing point,

$m_i = 1, 2, \dots, v_i$ ;

$v_i$  – number of capacity options at the  $i$ -th manufacturing point;

$A_i^{m_i}$  – amount of product that can be produced at the  $i$ -th point using the  $m_i$  capacity option;

$B_j$  – the need for the product at the  $j$ -th consumption point;

$$Z_{ij}^{m_i} = (C_i^{m_i} + EK_i^{m_i}) + T_{ij}, \quad (1)$$

where:

$Z_{ij}^{m_i}$  – reduced production costs at  $i$ -th manufacturing point with  $m_i$ -th capacity option and for transportation of a unit of product from the  $i$ -th production point to the  $j$ -th consumption point;

$C_i^{m_i}$  – unit cost of the product manufactured at the  $i$ -th manufacturing point using the  $m_i$ -th capacity option;

$K_i^{m_i}$  – capital investments per unit of product at the  $i$ -th production point when using the  $m_i$ -th capacity option;

$T_{ij}$  – transport costs for the transportation of a unit of product from  $i$ -th production point to  $j$ -th consumption point;

$E$  – capital investment efficiency ratio;

$X_{ij}$  – the required amount of product to be delivered to the  $j$ -th consumption point from the  $i$ -th production point;

$\bar{m}_i$  – the required capacity of the  $i$ -th production point.

#### Economic and mathematical formulation

The task will take the following form:

Find the required amount of product ( $X_{ij}$ ) to be delivered to the  $j$ -th consumption point from the  $i$ -th production point and the required capacity of the  $i$ -th production point ( $\bar{a}_i$ ), so that the total reduced costs (3) are:

$$Z = \sum_{i=1}^p \sum_{j=1}^n X_{ij} T_{ij} + \sum_{i=1}^p \bar{a}_i (\bar{C}_i + \bar{E}K_i) \rightarrow \min, \quad (2)$$

where: the cost and capital investment  $\bar{C}_i$  and  $\bar{K}_i$ , corresponding to capacity  $\bar{a}_i$ , are minimal under conditions:

1.  $\sum_{j=1}^n X_{ij} = \bar{a}_i, i = 1, 2, \dots, p$  – i.e. the total amount of product delivered to all consumption points from  $i$ -th production point is equal to the capacity  $\bar{a}_i$  of this point;
2.  $\sum_{i=1}^p X_{ij} = B_j, j = 1, 2, \dots, n$  – i.e. the total amount of product obtained in the  $j$ -th consumption point from all production points is equal to the given demand;
3.  $X_{ij} \geq 0, i = 1, 2, \dots, p; j = 1, 2, \dots, n$  (supplies must be non-negative);
4.  $\bar{a}_i = A_i^{mi}$ , i.e. selected capacity option at each production point must match one of the given options.

When preparing the initial information, it is necessary to adhere to the condition that the total amount of product according to the maximum possible capacity options of all production points should significantly exceed the total product demand for all consumption points.

When choosing equipment for a small enterprise, one should expect that it is possible to ensure full use of its capacity. For this purpose it is advisable to use the following mathematical model:

$$M = W_b \times K_{out} \times \frac{T_{use}}{t_c}, \quad (3)$$

where:

- $W_b$  – weight of the batch of raw material to be loaded in the production plant, kg or tons
- $K_{out}$  – output of finished product (useful substance)
- $T_{use}$  – useful operating time of the production plant during a year (season), hours
- $t_c$  – duration of one cycle of processing a batch of raw materials, hours.

An essential condition for the correct choice of equipment capacity:

$$M = W_b \times \frac{T_{use}}{t_c}, \quad (4)$$

where:

$\frac{T_{use}}{t_c}$  – number of cycles of raw material processing during a year (season),

$W_b \times \frac{T_{use}}{t_c}$  – amount of raw material that can be processed with the appropriate

equipment and operating mode during a year (season).

If the raw materials are seasonal (vegetables, fruits), then in this case one of the most important tasks is to increase the period of operation of the plant (enterprise). This can be achieved by means of construction of storage facilities to provide stocks of raw materials, purchase of modules (complexes) of equipment, which allows, with appropriate modification, switching to the production of other related products (for example: apple concentrate – drinks, etc.; tomato juice – various food seasonings, etc.).

In this case, the efficiency of capital investments into such enterprises and full, year-round, rather than seasonal employment of staff will be ensured [8, pp. 27-30].

## 6. Conclusions

Thus, it can be stated that under the conditions existing in the region, namely, fragmentation of land among small users, their economic freedom in choosing activities and lack of scientific support, the functioning of the regional agro-industrial complex cannot be effective, and there is a need to develop a scientifically-based model for the location of productive forces.

Given the geographical features of the region, such model should be based on:

- soil and climatic conditions of territories;
- concentration of land in modern business organizations (LLC, cooperatives, partnerships, etc.)
- gradual integration of agriculture with the processing industry;
- creation of modern mini-modules for the processing of agricultural raw materials and food production within the framework of economic structures.

It will also require improved rental relations between the state, which is the land owner, and the tenants. The basic principles of these relations should be commitment to ensuring the efficient use of land, leveling the differences in the socio-economic development of territories (districts), eliminating inefficient transport logistics for delivering raw materials to production sites and selling food products to consumers.

## REFERENCES

1. BODIUL, I.I. Memoirs. Tiraspol: 1990. 490 p.
2. BOS, H. Spatial dispersion of economic activity (in Russian, translated from English). Moscow: 1970. 157 p.
3. WEBER, A. Theory of the location of industries (in Russian, translated from English). Moscow: 1926. 220 p.
4. DEMIANENKO, A.N. Weber's theory of industry location: discussions of the beginning of the twentieth century. *Prostranstvennaya ekonomika (Spatial economy)*. 2008, no. 3, pp. 146-155.
5. IZARD, U. Methods of regional analysis: an introduction to regional science (abridged Russian translation from English). Moscow: 1966. 660 p.
6. LÖSCH, A. The Economics of Location (in Russian, translated from English). Moscow: 1959. 359 p.
7. MARSHALL, A. Principles of Economics (in Russian, translated from English). Moscow: 1983-1984, vol. 1, 416 p.
8. TRACH, D.M. Scientific Basics of Management. Rybnitsa: 2019. 300 p.
9. Website of the Ministry of Economic Development [Electronic resource] <http://mer.gospmr.org/>

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### Rezumat

*Dezvoltarea socială și economică de succes constituie sarcina primordială permanentă atât a fiecărei entități economice, cât și a statului în ansamblu. Acest fapt necesită o cercetare științifică continuă a factorilor interni și externi de dezvoltare. O importanță deosebită o are sarcina dată în contextul transformărilor fundamentale ale economiei în ansamblu și, în special, a agriculturii. Fragmentarea principalului mijloc de producție (pământului) pe utilizatori mici, nefinalizarea transformării relațiilor aferente formelor de proprietate în mediul rural, afectează negativ eficiența utilizării acestuia, dezvoltarea socio-economică atât a regiunilor în particular, cât și a statului în ansamblu. În articol sunt examinate starea și dezvoltarea sectorului agroindustrial din regiune, se identifică zăbovirea în elaborarea științifică a aspectelor metodologice și practice de reformare a acestuia. Un loc special, în acest context, o ocupă problema distribuirii spațiale a forțelor productive ale complexului agroindustrial.*

*În articol autorii propun un model economico-matematic de transport-spațiere pentru optimizarea dezvoltării și distribuirii forțelor de producție ale complexului agroindustrial din regiune.*

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**Cuvinte-cheie:** resurse funciare, complex agroindustrial, structură sectorială-ramurală, distribuție spațială a forțelor de producție, logistica aprovizionării și desfacerii



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**Аннотация**

Успешное социально-экономическое развитие всегда является главной задачей как отдельно взятого хозяйствующего субъекта, так и государства в целом. Это требует постоянного научного исследования внутренних и внешних факторов развития. Данная задача приобретает особое значение в условиях коренных преобразований в экономике в целом и в АПК в частности. Раздробленность основного средства производства (земли) по мелким пользователям, незавершенность преобразований отношений форм собственности на селе негативно сказываются на эффективности его использования, на социально-экономическом развитии как отдельно взятых регионов, так и государства в целом. В статье рассматриваются состояние и пути развития АПК региона, отмечается отставание в научной разработке методологических и прикладных аспектов его реформирования. Особое место в этом контексте занимает проблема пространственного размещения производительных сил АПК.

В статье предлагается экономико-математическая пространственно-транспортная модель оптимизации развития и размещения производительных сил АПК региона.

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**Ключевые слова:** земельные ресурсы, агропромышленный комплекс, отраслевая структура, пространственное размещение производительных сил, снабженческая и сбытовая логистика

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