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Management of agricultural crops production depending on land quality and intensification factors

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ABSTRACT

The article analyzes the methods of managing the production of agricultural products based on the quality of the land and the intensification factors. The purpose of this article is to determine the main factors that affect the production of agricultural products, develop recommendations to improve the management and analysis of crop production. The objectives of the study are: identification of the main factors that affect the efficiency of production of agricultural products; development of recommendations for the formation of self-sufficient segments of crop production in agricultural organizations and evaluation of the effectiveness of their operation; determination of an algorithm for the analysis and identification of deviations in crop yields due to intensification factors, organizational and management measures and land quality (soil) of cultivated areas. The introduction and use of economic methods to manage agricultural production requires the restructuring and formation of self-sufficient activity segments in medium and large agricultural organizations, which must operate on the principles of independence in matters of control, administration and evaluation of the recovery of the investment. The model (scheme) for the management of the self-sufficient segments of crop production is substantiated, the internal calculation prices are determined to evaluate the products produced by these segments and the net operating income of their activities.

KEY WORDS: Agricultural products; Agroindustry; intensification; Agricultural land; grain crops.

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Gestión de la producción de cultivos agrícolas en función de la calidad de la tierra y factores de intensificación

RESUMEN

El artículo analiza los métodos de gestión de la producción de productos agrícolas en función de la calidad de la tierra y los factores de intensificación. El propósito de este artículo es determinar los principales factores que afectan la producción de productos agrícolas, desarrollar recomendaciones para mejorar el manejo y análisis de la producción de cultivos. Los objetivos del estudio son: identificación de los principales factores que afectan la eficiencia de producción de productos agrícolas; desarrollo de recomendaciones para la formación de segmentos autosuficientes de producción de cultivos en organizaciones agrícolas y evaluación de la efectividad de su funcionamiento; determinación de un algoritmo para el análisis e identificación de desviaciones en los rendimientos de los cultivos debido a factores de intensificación, medidas organizativas y de gestión y calidad de la tierra (suelo) de las áreas cultivadas. La introducción y uso de métodos económicos para administrar la producción agrícola requiere la reestructuración y formación de segmentos de actividad autosuficientes en organizaciones agrícolas medianas y grandes, que deben funcionar sobre los principios de independencia en materia de control, administración y evaluación de la recuperación de la inversión. Se fundamenta el modelo (esquema) de gestión de los segmentos autosuficientes de la producción de cultivos, se determinan los precios de cálculo internos para evaluar los productos producidos por estos segmentos y los ingresos operativos netos de sus actividades.

PALABRAS CLAVE: producto agrícola; agroindustria; intensificación; tierra agrícola; cultivos de granos.

Introduction

The globalization of the agricultural economy and agricultural markets requires a significant increase in the efficiency of agricultural activities by significantly increasing the volume of agricultural production, improving its quality at normal costs and labor productivity. Achievement of these strategic objectives of agriculture is possible by considering all factors of agricultural production and prudent use of material, biological, land, labor, and financial resources in agricultural production. In addition, it is necessary to pay special attention to the development trends and issues of improving the organization of production, labor and payment in crop production and animal husbandry. All this requires the rationalization of the agricultural management system through the introduction and use of economic methods of production management.

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The introduction and use of economic methods for managing agricultural production requires restructuring and formation of self-supporting segments of activity in medium and large agricultural organizations, which should function on the principles of independence in matters of control, management, and evaluation of return on budget costs.

At the present stage of agricultural development, it is of great importance to significantly increase the volume of agricultural production, improve its quality, and increase production efficiency (Alborov et al., 2019).

In modern market conditions, the fundamental for effective development of the activities of any economic entities is to change the production management system through the widespread use of economic methods (Endovitsky et al., 2018). The main task of the management system is the development and implementation of management decisions (Ostaev, Suetin, et al., 2020).

The transition of farms at the end of the last century to the market led to the need to adapt production and management mechanisms to the requirements of the external environment, which first of all required the preservation and strengthening of labor discipline, independence, and initiative of management in setting and solving current and future problems (Kondratiev et al., 2020).

The main indicators of efficiency of agricultural production are crop yields and cost of the products obtained from them, as well as labor productivity, capital return, material efficiency, net operating income, etc. (Kontsevaya et al., 2020). There is an inverse relationship between yield of agricultural crop and unit cost of given agricultural crop (Ostaev, Shulus, et al., 2020). With an increase in yield per 1 hectare of given agricultural crop, the cost price of 1 centner of the product obtained from this crop decreases and, conversely, with a decrease in yield per 1 hectare of given agricultural crop, the cost price of 1 centner of production of this agricultural crop increases (Alborov et al., 2017).

A variety of technological, organizational, managerial, and other factors influence the efficiency indicators of agricultural crop production (Molchan et al., 2020). These factors include:

a) intensification factors: increasing the equipment of crop production with means of production; increasing the level of mechanization and automation of crop production processes; introduction of the most advanced active-adaptive technologies for production of

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agricultural crops; carrying out reclamation measures and cultural and technical works to artificially improve the fertility of land; improving quality of production capacities (machines, tractors, combines) by updating them and replacing physically and morally obsolete means of labor (fixed assets); use in the production process of the best categories of seeds, planting material, high-yielding varieties of agricultural crops, required quantity and quality of fertilizers according to special cartograms and crop rotation systems.

b) organizational and managerial factors (conditions): organization of rational placement and use of material and labor resources in crop production; application of the most progressive forms of organization of production process, labor, and payment in crop production; improvement of production management system by increasing the efficiency of its planning and prognostic, accounting and analytical, control and evaluation functions.

c) abiotic factors (conditions): light; heat; air (its composition and movement); moisture (precipitation, soil moisture, air).

d) edaphic factors: mechanical and chemical composition of the soil; physical properties of soil, its quality in general according to bonitet scores; relief of land (arable land, hayfields, etc.).

In addition to all the above factors and conditions, the level of yield and cost of agricultural crops largely depends on the observance of the time period for carrying out agrotechnological works in crop production (Karagodin, 2014).

Therefore, agrotechnological work (processes) in the production of agricultural crops must be performed in a strict sequence in accordance with the technological maps of agricultural crops (crop groups) and system of scientifically substantiated alternation in time and space (placement in the fields) in the field of crop rotation adopted in the organization. (Selezneva et al., 2020).

Timely implementation of all agrotechnological works in crop production will contribute to an increase in the efficiency of all factors (intensification, abiotic, edaphic) affecting the level of yield and unit cost of agricultural crops (Karagodin, Tsyguleva, 2021). To increase the effectiveness of the influence of organizational and managerial factors on the yield and self-cost of agricultural products, in our opinion, it is necessary to change the current semi-administrative system for managing crop production in agricultural

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organizations by gradually switching to economic methods of internal management (Frantsisko et al., 2020).

The introduction of economic methods of internal management requires its certain decentralization, in this case, in the crop production industry (Kokonov et al., 2019). In other words, it is necessary to transfer part of the internal management functions (planning and prognostic, accounting and analytical, control and evaluation) to the primary (structural) divisions of crop production. At the same time, preliminary work should be carried out on restructuring of crop industry and creation of self-supporting segments of activity in this sector of agricultural organizations, which should be as independent as possible, function on the principles of self-government, self-control, and self-sufficiency. The remuneration of employees in these self-supporting segments of activity should depend not only on the established categories of employees and prices for production unit and unit of work performed in crop production, but also on the operational financial results (operating net income) of production, performance of work in specific self-supporting segments of activities. All this will contribute to an increase in the material and moral interest of employees in self-supporting segments of activity, an increase in their stimulation to an increase in labor productivity, rational use of material, labor, and financial resources in crop production (Kontsevoi et al., 2020).

1. Methodology

The methodological basis of the study is to determine the main factors affecting the production of crop products. The study is based on materialistic dialectics, which determines the study of a phenomenon in any specific area of practice and scientific knowledge. The study is based on the works of domestic scientists and personal observations on the problems of using material, biological, land, labor, and financial resources in agricultural production. In addition, theoretical and practical factors of intensification, organizational and managerial, abiotic, and edaphic factors affecting the efficiency of production of agricultural products are studied.

The study proposes ways to rationalize the agricultural management system through the introduction and use of economic methods of production management. During the study, general scientific and special research methods were used: analysis, synthesis, modeling, methods of systematization and generalization of the results obtained.

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The new provisions are substantiated by the results of study and observations obtained by the indicated methods. The purpose of the study is to determine the main factors affecting the production of agricultural products, to develop recommendations for improving the management and analysis of the production of crop products. The object of the study is agricultural organizations, the subject of the study is the issues of production management and analysis of factors affecting the productivity of agricultural crops.

The significance of the study lies in the substantiation of indicators with the help of which it is possible to assess the quality of the intensification of crop production, the management of the efficiency of this production, as well as the impact of abiotic and edaphic factors on the yield of agricultural crops in quantitative terms.

2. Results and discussion

In the crop production industry, agricultural organizations are recommended to create one self-supporting segment of auxiliary production and several self-supporting segments of production as needed (Figure 1).

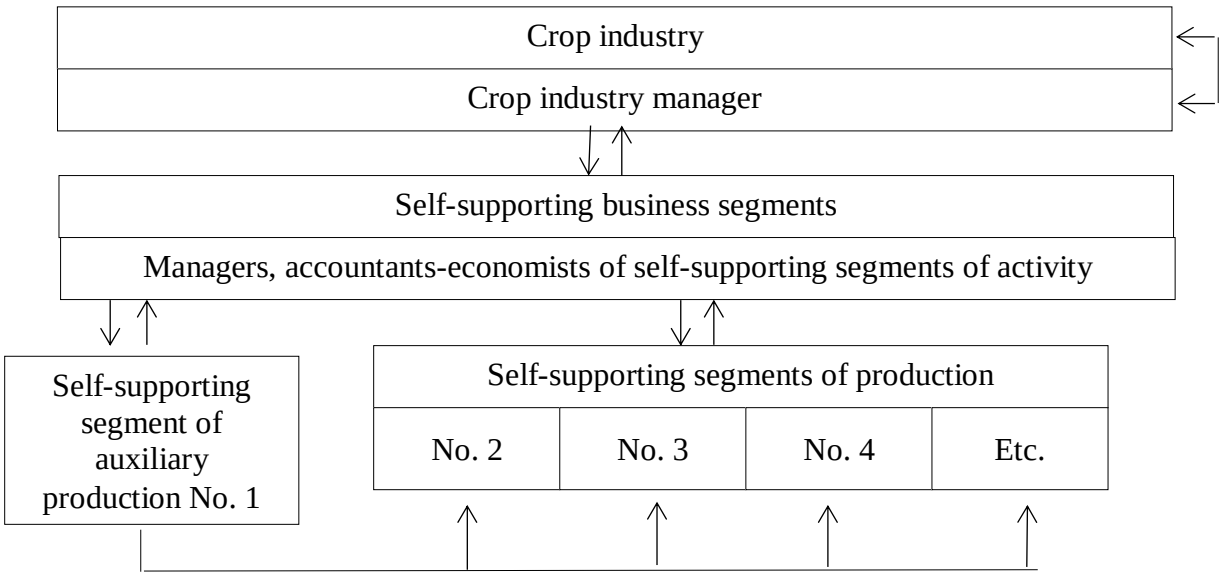

Figure 1. Management scheme for self-supporting crop production segments

The self-supporting segment of auxiliary production (machine and tractor brigade) performs all field mechanized work (plowing, pre-sowing soil cultivation, sowing, fertilization, crop care, harvesting, transportation work in crop production, etc.). Employees of this self-supporting segment will control their costs and the volume of work, as well as the

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final financial results of this self-supporting segment, that is, the received operating net income.

Self-supporting segments of production (crop production teams) grow crops and produce crop products (grain, potatoes, hay, green mass, root crops, vegetables, etc.). Employees of these self-supporting segments control their costs, the volume of product types received, their quality and the final financial result of production (operating net income).

At the end of each reporting year, the gross volume of work performed by the self-supporting segment of auxiliary production and the gross volume of products received, considering its quality, by each self-supporting segment of production is estimated at the internal estimated prices. By subtracting from the cost of the gross volume of work performed by the self-supporting segment of auxiliary production, the amount of costs for performing these works is determined by the operating net income of this self-supporting segment. By subtracting the costs of its production from the cost of gross product in each self-supporting segment of production, the operating net income is determined. At the same time, in our opinion, the basis for the development of internal settlement prices should be the variable cost of works and products, which includes all variable costs (depending on the volume of production, work performance) of given self-supporting segment of activity and its general production (variable) costs ... Thus, the internal estimated price per unit of work, unit of production of the corresponding self-supporting segments of activity can be determined by the formula:

$$\text{Iep} = \frac{Vpc}{Tpc} \times \text{Amv},$$

where Iep -is the internal estimated price per unit of work performed by the self-supporting segment of auxiliary production, unit of products received by the self-supporting segment of production, rubles.

Vpc– is the variable production cost per unit of work performed by the self-supporting segment of auxiliary production, units of products received by the self-supporting segment of production, rubles.

Tpc– is the total production cost per unit of work performed by the self-supporting segment of auxiliary production, unit of products received by the self-supporting segment of production, rubles.

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Amv– is the average market value of unit of work performed by the self-supporting segment of auxiliary production, units of products received by the self-supporting segment of production, rubles.

Using the internal settlement prices, the operating net income of the corresponding self-supporting segment of activities is calculated using the formula:

$$Oni = (Iep \times Qvwp) - \Sigma Cav,$$

where Oni is the operating net income for the volume of work performed by the self-supporting segment of auxiliary production, for the volume of production received by the self-supporting segment of production, rubles.

Qvwp is the volume of work performed by the self-supporting segment of auxiliary production, the volume of products received by the self-supporting segment of production, hectares of reference plowing, centners.

ΣCav is the cost amount for the volume of work performed by the self-supporting segment of auxiliary production, for the volume of products received in the self-supporting segment of production, rubles.

If any self-supporting segment receives operating net income from its activities, then this amount of operating net income should be used to accrue remuneration to employees of this self-supporting segment of activities for the final results based on the work results for the year.

Of great importance in increasing the efficiency of each self-supporting segment and crop production in general is the analysis and assessment of the influence of all of the above factors of production on the yield of agricultural crops, since everything depends on the level of yield of these crops: unit cost of the products received, productivity of labor, labor intensity of the products received and amount of operating net income from its production.

We will conduct such an analysis and assessment using the example of agricultural organizations of the Udmurt Republic, attributed to the zone of risky agriculture in Russia with a sharply continental climate, in terms of the yield of one of the main agricultural crops - grain crops (Table 1).

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Table 1. Assessment and analysis of grain crop yields by agricultural organizations of the districts of the Udmurt Republic

District names	Amount of grain harvest per 1 hectare for 2005-2019, c	Average actual grain yield per hectare, c	Soil bonitet score	Average normal grain yield per 1 hectare, c	Deviation of grain yield per 1 hectare:	
					Due to factors of intensification, organization and management, c	Due to the quality of land, c
	ΣHip	**Hfip**	**Bip**	**Hnip**	**Δ Hfipи**	**Δ Hnipb**
1. Alnashsky	286.5	19.1	81	15.9	+3.2	+1.6
2. Balezinsky	187.1	12.5	73	14.3	-1.8	-
3. Vavozhsky	383.4	25.6	67	13.1	+12.5	-1.2
4. Votkinsky	241.2	16.1	64	12.5	+3.6	-1.8
5. Glazovsky	205.9	13.7	73	14.3	-0.6	-
6. Grakhovsky	270.3	18.0	79	15.5	+2.5	+1.2
7. Debesky	214.9	14.3	75	14.7	-0.4	+0.4
8. Zavyalovsky	242.4	16.2	82	16.1	+0.1	+1.8
9. Igrinsky	213.7	14.2	70	13.7	+0.5	-0.6
10. Kambarsky	89.9	9.0	65	12.7	-3.7	-1.6
11. Karakulinsky	225.7	15.1	85	16.7	-1.6	+2.4
12. Kezky	165.8	11.1	71	13.9	-2.8	-0.4
13. Kiznersky	190.7	12.7	64	12.5	+0.2	-1.8
14. Kiyasovsky	203.4	13.6	76	14.9	-1.3	+0.6
15. Krasnogorsky	156.6	10.4	69	13.5	-3.1	-0.8
16. Malopurginsky	249.9	16.7	78	15.3	+1.4	+1.0
17. Mozhginsky	289.4	19.3	73	14.3	+5.0	-

18. Sarapulsky	228.5	15.2	79	15.5	-0.3	+1.2
19. Seltinsky	185.3	12.4	65	12.7	-0.3	-1.6
20. Yumsinsky	196.1	14.0	63	12.3	+1.7	-2.0
21. Uvinsky	222.0	14.8	65	12.7	+2.1	-1.6
22. Harkansky	239.1	15.9	76	14.9	+1.0	+0.6
23.Yukamensky	171.0	11.4	72	14.1	-2.7	-0.2
24. Akshur-Bodyinsky	128.6	10.7	68	13.3	-2.6	-1.0
25. Arsky	190.8	12.7	72	14.1	-1.4	-0.2
Σ У25р	5378.3	-	-	-	-	-
Average	У = 14.3		73	14.3	-	-

The indicators given in table 1 are determined according to the following calculation formulas:

Hfip = ΣHip: 15 years

Hnip = H: 73 × Bip.

Δ Hfipи = Hfip – Hnip.

Δ Hnipb = Hnip – У.

У = ΣУ25р: (25×15) = 5378,3: 375 = 14,3 с.

The data in column 6 of Table 1 (that is, Δ Hfipи) show the deviation of the actual grain yield per 1 hectare on average over the past 15 years for agricultural organizations of the districts due to intensification factors, as well as organizational and managerial measures.

In such districts as Alnashsky, Vavozhsky, Votkinsky, Grakhovsky, Igrinsky, Zavyalovsky, Malopurginsky, Mozhginsky, Syumsinsky, Uvinsky and Sharkansky agricultural organizations received an increase in grain yield per 1 hectare of sowing due to more effective use of intensification factors and organizational and managerial measures.

In other districts, such as Balezinsky, Glazovsky, Debessky, Kambarsky, Karakulinsky, Kezsky, Kiznersky, Kiyasovsky, Krasnogorsky, Sarapulsky, Seltinsky, Yukamensky, Yakshur-Bodyinsky and Yarsky agricultural organizations due to

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intensification factors, organizational -management measures have received less grain harvest. In the agricultural organizations of these areas, there is a lower level of intensification, weak use of intensification factors and organizational and managerial measures.

The data in column 7 of Table 1 (Δ Hnipb) show the deviation of the actual grain yield per 1 hectare of crops on average over the past 15 years for agricultural organizations in the districts due to the quality of the land.

In agricultural organizations of Alnashsky, Grakhovsky, Debessky, Zavyalovsky, Karakulinsky, Kiyasovsky, Malopurginsky, Sarapulsky and Sharkansky districts, they received an increase in grain yield per 1 hectare of sowing due to the higher fertility of the land.

Agricultural organizations of Balezinsky, Glazovsky and Mozhginsky districts did not receive any increase in grain yield per 1 hectare of sowing due to the coincidence of the quality of the land with its average level in all districts.

Agricultural organizations of Vavozhsky, Votkinsky, Igrinsky, Kambarsky, Kezsky, Kiznersky, Krasnogorsky, Seltinsky, Syumsinsky, Uvinsky, Yukamensky, Yakshur-Bodinsky and Yarsky districts received less grain harvest per 1 hectare of sowing due to the low quality of the land (below the average for all districts). Therefore, agricultural organizations in these areas should in the future take measures to increase the soil fertility of arable land (arable land).

Of the intensification factors, the yield of agricultural crops, in this case, grain crops, is most influenced by the amount of organic and mineral fertilizers applied to the soil, considering the quality of the land. In this regard, to improve the quality of the land (soil fertility) and the yield of grain crops per 1 hectare of sowing, as well as to optimize the doses of fertilizers applied to the soil, it is necessary to determine the quantitative parameters of the influence of these factors (doses of fertilizers in the soil, soil quality) for grain yield per 1 hectare of sowing. In addition to these two factors, the grain yield per hectare of sowing depends very much on the abiotic (climatic) conditions of growing grain crops.

Conclusion

In general, in the Udmurt Republic, the climate is characterized as sharply continental with large fluctuations within the given subject in the regions. Therefore, it is necessary to

establish the factor of the year for each district (that is, the effect of abiotic - climatic conditions of the year on crops yield).

This is necessary when conducting a factor analysis of crop yields using the correlation and regression method. In this case, the factor of the year, in our opinion, can be set (measured) in qualimetric units of measurement (coefficients or points). With the help of qualimetric indicators, it will be possible to quantify the quality of intensification of crop production, efficiency management of this production, as well as the impact of abiotic and edaphic factors on agricultural crop yields.

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