Development of convergence of agricultural sectors

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Abstract. The modern condition of agriculture is characterized by high degree of intensification and specialization, infringement of scientifically grounded structure of crop rotation and unbalanced application of organic fertilizers. This creates variety of environmental problems. This article is directed on definition of potential benefits of crop-livestock convergence through more efficient use of natural resources. The research objective was the complex estimation of development of sectoral convergence in agriculture using example of Krasnodar Territory. The article studies impact of livestock on crop. Dependence between farm animals and share of cultivated area occupied by perennial grasses has been revealed. It is proved that share of perennial grasses in structure of crop rotation partly depends on farm animals. The role of perennial grasses in crop rotation, their influence on the productivity of agricultural crops has been studied. Dependence between volume of application of organic fertilizers and yield of crops has been revealed. The assumption is substantiated that convergence of crop and livestock is highly adapted to maintenance of soil fertility. It is concluded that one of ways to solve identified problems is the development of convergence of crop and livestock by improving use of resources and reuse of waste.

1. Introduction
The strategic task facing domestic agriculture is production efficiency increase. However, desire of agricultural producers to increase profitability of agricultural sector of economy largely has caused strengthening of specialization of agriculture.

Last decade agriculture of Krasnodar territory is characterized by such trends as decrease in a share of livestock production in total volume of agricultural production, decrease in number of farm animals, and decrease in level of fertility of agricultural lands [1-2].

Further strengthening of specialization can lead to negative consequences: biodiversity decrease, environmental pollution.

Thereupon studying of possibilities of strengthening of interaction between crop and livestock is relevant. We believe that sectoral convergence can be considered as a factor of highly effective sustainable development of agriculture based on integrated use of crop and livestock resources.

Sectoral convergence in agriculture is a process of managerial, technological, economic and organizational interaction of crop and livestock based on a combination of their sub-sectors and inter-sectoral interaction in order to achieve maximum economic, environmental and social efficiency of production [3].

Research is based on the assumption that the development of sectoral convergence can accelerate qualitative economic growth of agricultural sectors and increase competitiveness of their functioning due to more efficient use of natural resources.
2. Materials and methods
The theoretical and methodological basis of the research was scientific works of domestic and foreign scientists devoted to problems of interaction between agricultural sectors, data from Ministry of Agriculture and Processing Industry of Krasnodar Territory and Federal State Statistics Service for Krasnodar Territory were used.

The instrumental and methodological apparatus of the research is based on such methods as monographic, economic-statistical, abstract-logical, etc.

3. Results
The main task of sectoral convergence in agriculture is reduction of used of external resources (purchased feed, fertilizers) and decrease in negative impact of production on environment.

Sectoral convergence in agriculture, as a combination of crop and livestock, may include following processes [4-6]:

- Crops which are grown on the farm can be used to feed farm animals, that minimizes import of external feed to production of livestock;
- Manure of farm animals used as fertilizer can serve as main source of nutrients for crop, thereby ensuring nutrient cycle;
- Agricultural by-products can be used to feed farm animals;
- Ruminant farming promotes inclusion of perennial legumes as main feed in crop rotation.

Consequently, the level of development of sectoral convergence in agriculture of Krasnodar Territory can be assessed by impact of its industries on each other in terms of inclusion of forage crops in the structure of crop rotation and use of manure as organic fertilizers, and consequences of such an impact on environment.

3.1 Crop rotation.

The share of perennial grasses in structure of crop rotation is one of indicators of efficiency of use of agricultural land. Perennial grasses provide many benefits, including biodiversity, preserving carbon storage in soils, and limiting nutrient leakage into water.

In Krasnodar Territory in 2019, about 13% of perennial legumes (legumes) in the structure of sown areas [8]. Basically these crops are sown by those who are engaged by livestock.

The share of perennial grasses in structure of crop rotation partly depends on farm animals, especially cattle, for which they are one of main sources of coarse and succulent feed [8].

Table 1 shows the influence of load of livestock and proportion of sowing of perennial grasses in the structure of sown areas on the yield of crops.

From 399 investigated agricultural enterprises of Krasnodar Territory only 36.8% had farm animals. Perennial grasses in cropping pattern provide ecosystem services, for example, in terms of soil stabilization (water and wind erosion), regulation of water and pollutant flows, regulation of nitrogen and phosphorus cycles, or by preserving pollinating insects, which has a positive impact on crop yields [1]. The introduction of manure also allows obtaining higher yields of crops.

Thus, ruminant breeding systems play a central role in regulating nutrient cycling or maintaining soil fertility, preserving biodiversity.

3.2 Organic fertilization.

Organic fertilization is one of the main sources of nutrients for crops. With a reasonable choice of processing technology and proper use, this production waste can become a valuable product which it is advisable to apply as organic fertilizers [9, 10]. Use of manure as organic fertilizer provides soil with organic matter, increasing its fertility, improving its structure and water-holding capacity.

Annual application of organic fertilizers in Krasnodar Territory is in the range of 1-2 tons / ha [7].

Organic fertilizers are applied by agricultural producers in the form of farm animal manure – 3.5-4.0 million tons annually, post-harvest residues of agricultural crops – to 7 million tons, green manure crops are embedded in soil on an area of 5.3 thousand hectares. The situation with application of
organic fertilizers in municipalities of Krasnodar Territory in 2019 shows that the largest share of application of organic matter falls on collective farms and peasant (farmer) farms engaged in breeding farm animals, mainly cattle. During the period from 1990 to 2019, the application of bedding manure decreased from 13 tons / ha to 2 tons / ha, or 6.5 times [7].

**Table 1.** The influence of perennial grasses on yield of crops in agricultural organizations of the Krasnodar Territory (2018).

| Groups of agricultural organizations by share of perennial grasses in structure of sown areas | Total and average |
|---|---|
| 0% | less than 10% | more than 10% |
| The number of agricultural enterprises in the group, units | 215 | 119 | 65 | 399 |
| of which: do not contain livestock | 200 | 42 | 10 | 252 |
| contain livestock | 15 | 77 | 55 | 147 |
| incl. in the amount of up to 20 conventional heads per 100 hectares of sown area | 9 | 62 | 25 | 96 |
| in the amount of 20 or more conventional goals per 100 hectares of sown area | 6 | 15 | 30 | 51 |
| The share of perennial grasses in structure of sown areas on average for group,% | 0 | 3,8 | 13,6 | 1,2 |
| Yield, centner / ha | | | | |
| Winter wheat | 60.0 | 63.8 | 66.4 | 62.2 |
| Corn | 49.7 | 52.2 | 56.3 | 51.6 |
| Sunflower | 27.4 | 28.0 | 29.6 | 28.0 |
| Sugar beet | 493.2 | 501.7 | 534.5 | 504.1 |

The grouping of municipalities in the region on application of organic fertilizers per 1 ha of fertilized area demonstrates the relationship of development of crop and application of organic fertilizers (table 2).

**Table 2.** Impact of fertilizers on the efficiency of crop production in the Krasnodar Territory (2019).

| Groups of municipal districts for application of organic fertilizers per 1 hectare of fertilized area | Total and average |
|---|---|
| 152.1-130.0 | 40.7-92.3 | 1.4-30.0 |
| The number of municipal districts in the group, units | 5 | 11 | 12 | 28 |
| Organic fertilizers applied, thousand tons | 232.5 | 154.1 | 71.7 | 152.8 |
| Per 1 ha of the entire sown area, tons | 2.6 | 1.6 | 1.4 | 1.9 |
| Fertilized area, thousand ha | 1.8 | 2.5 | 5.7 | 3.3 |
| Per 1 ha of fertilized area, tons | 131.2 | 61.8 | 16.6 | 69.9 |
| Weighted average humus content,% | 3.8 | 3.7 | 3.8 | 3.8 |
| Grain crops yield, kg / ha | 58.5 | 59.1 | 56.1 | 57.9 |
| Profitability of crop production,% | 37.6 | 36.7 | 33.8 | 36.0 |
The higher economic indicators is associated with benefits of convergence in crop and livestock processes, which can reduce operating costs and increase economic efficiency through use of own resources: fertilizers, crop protection products and labor resources.

According to the data of the FGBU CAS "Krasnodarsky", the total amount of manure output of Krasnodar Territory in 2020 will amount to 2569 thousand tons. This volume of manure output is determined based on farm animals available at the end of 2019 in Krasnodar Territory. In addition, for January, 1st, 2020, 1296 thousand tons of manure were stored in the region. The planned application of manure for Krasnodar Territory in 2020 cannot exceed 3865 thousand tons.

A decline in livestock numbers [11] may have negative consequences for soil organic matter levels and soil biodiversity, with additional negative impacts on soil fertility and productivity. The need to increase crop yields may lead to an increase in the use of chemical fertilizers and pesticides, leading to additional problems related to water and soil pollution.

Thus, the increase in soil fertility due to introduction of manure as organic fertilizers is not ensured by animal husbandry. It should be noted that, as well as the absence of farm animals on the territory and the excessive territorial concentration of farm animals can damage the environment.

Thus, it is necessary to develop agricultural systems with high and stable profitability while meeting environmental standards for greenhouse gas emissions, consumption of fossil energy resources, maintaining soil fertility, biodiversity, etc.

4. Discussion
The modern condition of agriculture in Krasnodar Territory is characterized by a high degree of specialization, non-compliance with required crop rotation by all agricultural producers, as well as the massive use of resources such as pesticides, mineral fertilizers and feed concentrates. It is fraught with many challenges: intensification, landscape homogenization, soil degradation, declining biodiversity, pollution and depletion of natural resources, which prompts agricultural producers to rethink agricultural practices. The main challenge facing regional agriculture is creation of socially, economically and environmentally acceptable production systems, which requires the development of livestock. In this case, it becomes possible to form a close interaction between the biotechnical subsystems of crop and livestock, which will help to achieve a balance between the intensity of industries, strengthen economic performance of farms and help improve environmental performance by reducing risk of air, water and soil pollution. The convergence of crop and livestock is highly adapted to maintain soil fertility and reduce dependence on external farm resources.

We believe that the convergence of crop and livestock is an effective way for sustainable (or ecological) intensification, which necessitates of increase in agricultural productivity while preserving environment.

5. Conclusion
Converged agricultural systems foster interactions between industries and create opportunities for exchange of resources between them. In combination with crop, livestock allows: to reduce amount of purchased fertilizers by supplying organic fertilizers; improve soil fertility and reduce need for fertilizers and plant protection products by improving the structure of crop rotations and increasing a share of forage crops.

Such systems provide opportunities for use of ecosystem services, such as maintaining soil fertility or biological regulation of pests and diseases. In an agricultural context, ecosystem services are an product of interaction between agricultural biodiversity and livestock biodiversity.

It can be concluded that the sustainable development of agriculture in Krasnodar Territory, aimed at increasing efficiency of agricultural sector of economy, while maintaining quality of environment, is possible only if the policy of developing sectoral convergence is implemented. This approach contributes to achievement of synergies between the various goals of sustainable development, necessary for accelerated growth of the region's economy.
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