World Academy of Science, Engineering and Technology
International Journal of Agricultural and Biosystems Engineering
Vol:13, No:1, 2019

The Features of Formation of Russian Agriculture's Sectoral Structure

Natalya G. Filimonova, Mariya G. Ozerova, Irina N. Ermakova

***Abstract*—**The long-term strategy of the economic development of Russia up to 2030 is based on the concept of sustainable growth. The determining factor of such development is complex changes in the economic system which may be achieved by making progressive changes in its structure. The structural changes determine the character and the direction of economic development, as well as they include all elements of this system without exception, and their regulated character ensures the most rapid aim achievement. This article has discussed the industrial structure of the agriculture in Russia. With the use of the system of indexes, the article has determined the directions, intensity, and speed of structural shifts. The influence of structural changes on agricultural production development has been found out. It is noticed that the changes in the industrial structure are synchronized with the changes in the organisation and economic structure. Efficiency assessment of structural changes allowed to trace the efficiency of structural changes and elaborate the main directions for agricultural policy improvement.

***Keywords*—**Russian agriculture system, sectoral structure, organizational and economic structure, structural changes.

I. Research questions

TRANSFORMATION of a system is mainly maid by changing of its structure, in particular, by changing the number of elements, links, and relations between them. When changing, its structure determines a system's quality [1]. Therefore, it is necessary to deepen the analyses of structural properties since it answers the question of transformations suitability and system functioning efficiency.

The aim of this research is to study the dynamics of Russian agriculture's sectoral structure and assess the efficiency of structural changes. That is why we have assessed the condition of agriculture's branchial structure by analyzing the share composition of main subindustries in the whole body of agricultural production, comparing the achieved results with the optimal indices. Moreover, we will assess structural transformations using an indices complex, as well as evaluate structural change's impact on the agricultural development.

II. Data and Methods

The scoop of the research is agricultural sectors in the system of their economic interrelations; the subject is the processes of economic transformations in Russian branchial structure. The methodological basis of the research is system, complex and evolutional approaches, together with logical and statistical analysis [2]. Informational basis of the research is official materials of statistical reports of the Federal Service of State Statistics [3], and analytical information of the Ministry of Agriculture of the Russian Federation [4].

M. G. Ozerova and I. N. Ermakova are with Krasnoyarsk State Agrarian University, Russia (e-mail: natali_f08@ mail.ru).

N. G. Filimonova is with Krasnoyarsk State Agrarian University, Russia (e-mail: natali_f08@ mail.ru).

III. Main Results

In the Russian Federation, in the course of agriculture formation as an independent branch under the influence of social labor differentiation such production structure has shaped so the ratio between the industries of animal husbandry and plant growing is 65:35. However, reformation of agricultural sector that started in the beginning of 90-s, related to change of the whole agriculture relations system, led to new structural ratios. As of 1991, plant growing started to take a leading position while animal husbandry faced certain processes that led to its shrinking (Table I).

TABLE I
Russian Agricultural System's Sectoral Structure (In Actual Contemporary Prices), %

Industry, type of product	Years					
	1990	1995	2000	2005	2010	2016
Plant growing—total Including:	36.7	53.1	55.1	48.5	45.1	55.1
Cereal cultures	9.5	12.5	16.5	13.8	10.5	16.8
Potato	7.2	17.9	15.8	11.9	10.7	12.9
Vegetables and melons	7.5	9.9	10.9	9.9	10.5	10.5
Feed crops	5.4	5.4	3.9	3.4	2.8	3.0
Industrial crops	4.5	3.3	2.8	4.3	5.6	6.0
Fruit and berries crops	1.4	2.8	4.5	4.0	4.2	4.9
Others	1.2	1.3	0.7	1.2	0.8	1.0
Animal husbandry—total Including:	63.3	46.9	44.9	51.5	54.9	44.9
Cattle and poultry	32.6	20.2	20.8	26.6	30.2	24.0
Milk	20.5	18.8	17.0	17.8	18.4	15.2
Wool	1.3	0.5	0.2	0.1	0.1	0.1
Egg	7.7	4.8	4.4	4.9	4.2	3.6
Others	1.2	2.6	2.5	2.1	2.0	2.0
Agricultural products -total	100	100	100	100	100	100

The reasons of such radical structural changes were related to the change of a social and economic model, as well as to the governments dissociation from strategic regulation of the industry's developmental programs; the abovementioned caused spontaneous reconstruction. This period is characterized by high speed and deepness of structural changes, as well as achievements discrepancy and low efficiency of agricultural system efficiency (Table II). Maximum change of industries' share size was observed from 1990 to 1995, at average of 3.16%. Quadratic coefficient of

relative structural changes that shows intensity of unit weight changes (in percent) made 52.4%, i.e. from 1990 to 1995, unit weight of the industries in the production structure changed by half from its initial value. Within this period, the primary role in the structural changes belonged to potato growing, which share increased by two and a half times, however, production started to be performed at private farms. Together with the structure of gross production, meat and poultry production impetuously decreased, annually at the rate of 3.1% or 11.3%. Increase of certain industries' shares and decrease of the others were conditioned also by differentiation of the economic improvement pace. When studying statistical production improvement indices based on the basic agricultural products, its different paces may be noticed. This way, decrease intensity at average annually made 14.1% for crops production, 13.0% for slaughter intended animals and poultry, 8.4% for milk, and 8.1% for eggs. The highest average decrease pace is noticed in the sheep husbandry industry, where annually wool production reduced by 19.9%. On the whole within this period expenses on executing one percent structural changes may be estimated as 2.02% of production decrease.

TABLE II
SUMMARIZING INDICES OF STRUCTURAL CHANGES

Index	Period, years				
	1990–1995	1995–2000	2000–2005	2005–2010	2010–2016
Linear coefficient of absolute structural shifts, $K = \frac{\sum_{i=1}^{n} \lvert D - D_o \rvert}{n}$	3.16	1.26	1.51	1.05	1.66
Quadratic coefficient of absolute structural shifts, $\sigma = \sqrt{\frac{\sum_{i=1}^{n} (D - D_o)^2}{n}}$	4.93	1.60	2.26	1.54	2.80
Quadratic coefficient of relative structural shifts $\sigma_o = \sqrt{\sum_{i=1}^{n} \frac{(D - D_o)^2}{D_o} \cdot 100}$	52.36	19.59	20.1	14.8	25.2
Linear coefficient of absolute structural shifts during *t* of the periods, $K_t = \frac{\sum_{i=1}^{n} \lvert D - D_o \rvert}{n(t-1)}$,	0.79	0.30	0.38	0.26	0.41
Efficiency of a structural shift $Эс = \frac{T_b}{M_o}$	0.870	1.095	1.079	1.066	1.003

D – proportion structural indicator in the current period (%), D_0 – proportion structural indicator in the base period (%), i = 1, 2,…, n – number of elements in the structure, t – structural shift time, T_b - rate of development of branch (%), M_o - mass of the structural break in relative terms (%), k -number of gradations in the structure.

From 1995 to 2000 when maintaining the direction, the speed of structural changes slowed. The absolute structural shift made 1.26 percent, quadratic coefficient reduced from 4.93 to 1.60. As a result by 2000, new structural orienteers were defined, i.e. plant growing made 55% of the whole volume of agricultural production, while animal husbandry made 45%. An important factor in the evolution of industrial structure of agriculture of this large period (1990–2000) was the fact that the changes were happening simultaneously with material production shrinking. The calculation has shown that in plant growing every share's percent of change in the structure brought only 0.24% of production volume growth, while in animal husbandry such structural changes led to negative values. The production volume decreased by 8.83% in response to the change of animal husbandry position by 1% in the industrial structure.

A new stage of Russian agricultural sectoral structure correction began in 2001. Under the influence of market factors, the animal husbandry industry started to restore its share in the branchial structure. As of 2005, this process was accelerated by implementation of a new agricultural policy. Animal husbandry as an industry was acknowledged to be a multiplier that, being a powerful economic growth booster, forms a developmental axis for all related subindustries and productions, as well as assists in forming a new model of sectoral structure. By 2010, the proportion between the leading agricultural branches of plant growing and animal husbandry had harmonized in the ratio of 45:55. Integral figure of structural changes, which is equal to 0.095, shows that the industrial structures of 1990 and 2010 had a low level of structural differences. At that, agriculture started to improve. The annual growth pace in plant growing industry for the period of 2000–2010 made 1.2%, while in animal husbandry it made 2.3%. Nevertheless, the food safety indices did not correspond to norms in terms of animal husbandry products. In particular in 2010, the unit weight of domestic milk and dairy products made 80.5% (while the established norm is not less than 90.0%), meat and prepared meat made 72.2% (while the established norm is not less than 85.0%), in the whole amount of domestic market resources.

It was expected that after implementing a food embargo in 2014 in Russia, the ratio of the leading agricultural branches will keep the optimization trend as the issue of food independence and self-sufficiency became really sufficient. However, landowners' focus on growing marginal cultures with highly export potential has led again to the expansion of

plant growing share in gross product structure. Within the latest times, the average annual change of industrial shares in production structure has become significant again making 0.41%.

By comparing the industrial structures of various years with the basic one (of the year of 1990) which is considered the most optimal for Russia, we have calculated the structural differences coefficient:

$$K_j = \sqrt{\frac{\sum_{i=1}^{n} \left(\frac{D - D_o}{D + D_o}\right)^2}{k}} \quad (1)$$

$K_{j_{1995}} = 0{,}258 \quad K_{j_{2000}} = 0{,}349 \quad K_{j_{2005}} = 0{,}3255 \quad K_{j_{2010}} = 0{,}3365 \quad K_{j_{2016}} = 0{,}3626$

The assessment of structural difference extent is made with the use of the scale. If the value is from 0 to 0.2, it means that the difference level is not significant; if it is from 0.2 to 0.5, it is significant; if it is from 0.5 to 0.7, it is very significant, from 0.7 to 1 is high. The index values obtained during calculations mean that compared industrial structures have significant differences. In 2016, the index achieved its biggest value.

In order to analyze a multiplicative effect of structural shifts, the matrix of cross coefficients of correlation between a unit weight of the industrial structure has been calculated. The most significant effect of structural shift multiplier is achieved in the industries with high correlation coefficient in comparison with other industries. Strong linear bonds are observed between grain production, feed production, cattle-breeding and swine breeding. Strong linear relationships between crops production are demonstrated, forage production, animal husbandry, and pig breeding. Also, an increase in crops production share leads to a sharp decrease in unit weight of rest industries and vice-versa. In addition to that, during the studied period the expansion of plant growing industrial share was accompanied with the reduce of production volume in cattle breeding caused by resources redistribution. The most sensitive branch appears to be dairy cattle breeding which, despite governmental attempts to restore it, failed to stop the tendency to its negative development. In 2016, the level of production in such important industry was just 55.2% comparing to the one of 1990, which satisfied the population's demand for 72.6% of a reasonable consumption norm [5]. Negative elasticity coefficient indicates industry's high sensitivity towards structural changes and economic impact delay. Thus, current structural changes may even aggravate this negative tendency of failing to develop the industry.

Result assessment of changes in the industrial structure is made with the use of the index of self-sufficiency with the main types of agricultural products, which is calculated as the ratio of domestic production volume to the goods resource volume (considering carry-over storage) of the domestic market (Table III). The table's data show that, by 2016, food security criteria had been provided for by all types of products except for milk. During a short period of time due to stable growth pace production of volume that is enough for population's demand happened to be achieved.

TABLE III
UNIT WEIGHT OF DOMESTICALLY PRODUCED AGRICULTURAL PRODUCTS, RAW MATERIAL AND FOODS IN THE WHOLE AMOUNT OF THE RESOURCES (CONSIDERING CARRY-OVER STORAGE) IN THE RUSSIAN FEDERATION, %

Types of agricultural production, raw material and foods	Years			Threshold value *
	2010	2015	2016	
Grain	99.4	99.2	99.2	95
Vegetable oil	76.6	82.5	83.7	80
Sugar (produced from sugar beet)	57.6	83.3	88.3	80
Potato	96.3	97.1	97.5	95
Milk and dairy products	79.7	79.4	80.3	90
Meat and meat products	71.4	87.2	88.7	85

* - In compliance with the Russian Federation Food Security Doctrine [6]

Thus, dairy cattle breeding's share is decreasing in the industrial structure and it happens at a time when production volumes are going down, import substitution issue has not been solved yet, as well as it does not meet people's satisfaction with milk and dairy products. Chosen direction of embedding Russian agricultural sector into international labour differentiation may lead to asymmetry in industrial structure without providing for restoration growth in cattle breeding.

Another important component of structural changes is connected with the shift of production in terms of agricultural goods producers. Within the market transformation, a certain labour differentiation has formed: agricultural organization are focused on production of grain and oil oil-bearing-crops, sugar beet, poultry and swine breeding; big share of peasant (farm) enterprises is focused on grain production, oil-bearing-crops and sheep-breeding; private farms produce the main part of potato, vegetables, berries, beef and mutton, and a half of milk. Together with that, within last five years, the following tendency is observed: production at sophisticated and resource consuming industries, such as production of cattle, poultry, milk, potato and vegetables, moves from private farms, so their share in the production structure decreases, and at the same time the role of peasant (farm) enterprises and large agricultural organizations simultaneously grows In the same time, the market focuses on market volume increase by agricultural holding's products due to fast consolidation pace of agricultural business. These processes are rather reasonable. Firstly, because it is profitable for trade networks to purchase products in big amounts and desirably from one supplier. Secondly, a processer is willing to shorten and cheapen his/her logistics chain. Thirdly, a consumer tends to look for a known brand. Moreover, the role of not the least importance belongs to the fact that all agricultural products are purchased by consumers at large trading networks, and there are not much real farm markets in Russia.

Are the current consolidation processes effective from the point of view of agricultural production, as well as of social aspect? This question has been up-to-date since the times of the economist named Chayanov, who studied the optimal size of a company [7]. Modern research tends to believe that 2–2.5 hectares of land and several hundreds of cattle heads is an

acceptable size for an effective agricultural company. However, contemporary agricultural business is characterized by a growing share of agricultural holdings in production of most types of agricultural products. In Russia, agricultural holdings and agricultural complexes that unite various in size agricultural organisations and their branches, which are established on the basis of former agricultural organisations and are under control of the head organisation, are widespread. In certain cases, they exist in the form of one organisation with branches; the largest of which control hundred thousands of hectares of farmland and up to 20 thousand of employees in agriculture, they ignore an opportunity of contracting with farmers, which radically differs from the situation in the contemporary agriculture of leading agricultural countries.

The tendency to consolidated growth at the present stage of poultry and pig growing is visible. So, 67% of poultry meat and 54% of pork from the whole production volume at agricultural enterprises is produced by large agricultural holding, among which the first three are Cherkizovo, Prioskolye, and Miratorg. In the plant growing industry, agricultural holdings occupy 6.5 million hectares of cultivated areas, which makes 8% of the all-Russian index. In the industry, the leader as per cultivated areas is Prodimeks with 690 thousand hectares, Miratorg with 560 thousand hectares, and N. Tkachev Agrokompleks with 460 thousand hectares. Main cultivated agricultural crops define an agricultural holding's specialization. In this very case, correspondently sugar beet, feed crops, and grain crops. Due to low margin level caused by price crisis, high farm reconstruction and modernization, there is a bit lower level of business consolidation in the milk industry. Thus, there are not many large manufacturers, the main of which are EcoNiva, Molochny Product, Ferma Rosta, and Kabosh.

Large agricultural holdings by comprising all the links of foods production chain from land work to production of final product contribute to restoration growth in agriculture, effective food import substitution under the principle of large-scale industrial production. Serova sees strong sides of agricultural holdings in competitive advantages in the world market, effective administrative structures and strong negotiating power over market partners [8]. At the same time, many researchers are concerned about the growth of agricultural production scale, which stands for the risks of monopolization of food supply, minimization of tax profit due to transfer prices inside a holding, ecological issues, social and economic stability [9]. Thus, the researches made by Shagayda and Uzun prove that concentration of hundred thousand hectares of land not only undermines competitiveness conditions (for land and state subsidies) between the subjects of entrepreneurship, but also is not effective [10]. A large scale of business is effective only up to a certain limit (7–10 thousand hectares for one company), over that limit the effectiveness decreases. Meanwhile, the state sees support in agricultural holdings and included them in the lists of system forming enterprises, which contributes to normalization of agricultural structure. In this case, creation of competitiveness institutions for mass produces would be more preferable. Farms and private farms are attributed to them.

In compliance with Russian legislation, farms may perform business as a legal entity or without incorporation, their head is registered as an individual entrepreneur. According to agricultural census of 2016, there are 174.6 thousand farms and farming individual entrepreneurs in Russia.

According to Russian Federal Service of State Statistics, their number has decreased by 40% within the last 10 years, however, the rest of them have increased their cultivated areas by 2.5 times, which makes 269 hectares per one farm at average. However, there are some large and extra-large family farm enterprises that cultivate areas of up to 5–20 thousand hectares.

Over recent years, due to grant support, farms become active participants of agricultural business. However, the average level of state support (subsidizing amount for one ruble of gross production, rubles) for farms is 30% lower than for agricultural organisations, which again stands for unequal competitiveness conditions.

The one more sector is private farming. It is a unified name for private activities in agriculture, which are performed at land plots of various intended use by citizens and their families. Development of family farming appeared due to private interests of farmstead owners, which is related to improvement of their farms as the main source of food and income for a village family. The basis for that form of farming is archaic production which is gradually shrinking. However, shrinking is not always compensated by increase in agricultural organisations and farming enterprises, since the state did not contribute to people working in their private land plots and gardens to leave their archaic way and create goods producing farms. Therefore, it is reasonable to say that the clearly differentiated structure of agricultural sector, which is presented on the one hand by large horizontally and vertically integrated structures and small farm enterprises on the other hand, has appeared. In terms of rural area development, the process of agricultural business globalization has as advantages, represented by social infrastructure improvement, as disadvantages caused by reduce in employment of rural people due to the rise in labor efficiency. The solution may be found in recognition of agricultural goods producers' heterogeneity, as well as their equal development, and possibility to incorporate farmers into agricultural holdings with the help of related international cooperation experience. This is important since peasant enterprises are the basis of social wellbeing in rural areas, because they allow to solve the issues of people's self-employment, to keep the rural way of life by performing folk arts and crafts, form and develop agricultural productions that does not bring profit to large businesses, but are in demand among consumers.

IV. Summary

The structure of Russian agricultural industry is rather dynamic. The research of the transformations has allowed to define four stages of the industry's development. In the first period that embraces the years of spontaneous market changes (of 1990–2000), there has been noticed the high speed and

deepness of structural changes in agricultural economy, as well as discrepancy of the results and low efficiency of agricultural system functioning. In the period from 2000 to 2005, new positive changes are analyzed, which were enabled by stabilization of economic environment, particularly due to the self-regulation processes. As of 2015, due to formation of a new agriculture policy several structural extremes were happened to be leveled. However as of 2015, new changes that caused alertness outlined again. Those changes are represented by plant growing sector enlarging; together with the decrease in animal produce due to the problem of food safety in milk and dairy products has not been solved. Among the factors that have caused structural changes, agricultural businesses' export potential improvement should be mentioned. With this business aiming to cooperate with external market, resources transfer is enabled as well as technologically and organizationally complex animal production industry becomes more visible. The changes in the industrial structure are synchronized with the changes in organizational and economic structure. Farmer's interest in grain crops production for export grows. Poultry and pig farming are concentrated in agricultural holdings. Meat and milk animal husbandry is located in medium-size enterprises and farms. Over recent years, the concentration processes are becoming hypertrophic: holdings force out other forms of agricultural business, vast territories are under their control. The level of state support and business making conditions differs for different forms of agricultural business, which does not comply with the principles of equal competitiveness. The agricultural structure's improvement is seen in changing the unequal competitiveness conditions to unified availability to state support, as well as in support to small- and medium-scale farming for their mass development, together with their cooperation and contracting with large-scale business.

REFERENCES

[1] Bertalanffy, l (1968). General System Theory: Foundations, Development, Applications. N.Y., George Braziller, lnc.
[2] R. A. Shamoylova, V. G. Minashkin, N. A. Sadovnikova, etc., (2014). The Theory of Statistics, Moscow.
[3] Agriculture, Hunting, and Forestry in Russia, Statistical book (2015), Moscow: Federal Service of State Statistics.
[4] National report named "About the Course and Results of Realization in 2016 of the State Program of Agricultural Development, and Regulation of Agricultural Products, Raw Materials, and Food Markets within 2013–2020". Ministry of Agriculture of the Russian Federation. Available at http://mcx.ru/upload/iblock/e6e/e6e33a1636b2a9db6f458bfed4312382.pdf.
[5] About ratification of guidelines on foods consumption rational norms, which comply with contemporary requirements of healthy diet: Order No. 614 as of 19 August 2016of the Russian Federation Ministry of Healthcare and Social Development available at http://www.consultant.ru/document/cons_doc_LAW_204200/.
[6] The Russian Federation Food Security Doctrine: the President's decree No. 120 as of 30 January 2010, available at http://mcx.ru/upload/iblock/62b/62b8c9dc97514c2802af54bd28f7feff.pdf.
[7] A. V. Chayanov, Farm Agriculture. Moscow: Economics, 1989. – 491 p.
[8] E. Serova, Sustainability of agroholdings in Russia and only. IAMO Forum, 2018. Available at https://forum2018.iamo.de/microsites/forum2018.iamo.de/fileadmin/presentations/Mittwoch/P1_Serova.pdf.
[9] Richard J. Sexton Large scale agriculture and agribusiness in era of conflicting consumer and societal demands. IAMO Forum, 2018. Available at https://forum2018.iamo.de/microsites/forum2018.iamo.de/fileadmin/presentations/Mittwoch/P1_Sexton.pdf.
[10] N. I. Shagayda, V. Ya. Uzun, Development Tendencies and Main Challenges of Russian Agriculture Sector: analytical report. Moscow: Russian Presidential Academy of National Economy and Public Administration — Strategic Research Center, 2016. – 94 p.