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Analysis of Changes in Technical Efficiency of Russian Agricultural Organizations During the Reform Period

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Abstract—The article analyzes the dynamics of the technical efficiency of agricultural organizations since the beginning of the reforms. The presence of a considerable number of non-effectively used and redundant resources, because of both the poor organization of farms and the insufficient development of market institutions in Russia, has been discovered. In general, based on the analysis, it has been concluded that there is a positive impact of market reforms on technical efficiency of agricultural organizations.

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More than 20 years have passed since the beginning of reforms in the agricultural sector in Russia. Ongoing reforms were accompanied by a sharp decline in agricultural production and bankruptcy of agricultural organizations. Former collective and state farms, converted to new organizational and legal forms, tried to rebuild the production and management in a way that could allow them to survive under new economic conditions. Currently, 16 large- and medium-sized agricultural enterprises produce 75% of domestic grain and legumes, 70% of sunflower, 55% of milk, and 63% of meat and poultry in live weight. Not all organizations have a high degree of productivity and efficiency. Below, we analyze the changes in the efficiency of farms during the years of reforms and how successful their efforts were at managing the available resources under market conditions.

The indicator of profitability, which reflects the economic side of the business, is commonly used in economic science and practice of Russia for this purpose. While the way certain types of resources, such as land, labor, capital, and number of animals, are used in farms is out of sight. Western economic science uses approaches of the so-called evaluation of technical efficiency of enterprises from the late 1950s. This rating is a comparison of performance indicators of output per unit of resource with the maximum possible indicators under the given circumstances; therefore, the economies are compared with each other in the degree of use of their resources. The best indicators that ensure the maximum yield per unit of resource are taken as a benchmark.

A production function on estimated parameters of output per unit of resource for the best from these farms is built for a comparison of the companies; in other words, efficient enterprises form a so-called “border of the technical efficiency of production.” Indicators of the “reference farms” lie along this border. The ratio of the actual output of production to the maximum possible is taken equal to one or 100% on the production possibility frontier. Thus, the measurement of technical efficiency lies in identifying discrepancies of indicators between any farm from the study and the resulting efficiency boundary. Defining the boundaries of technical efficiency is carried out mainly by two methods in the Western literature. First, this can be done by constructing a production possibility function for the most efficient advanced agricultural enterprises using methods of mathematical statistics, i.e., by the stochastic production function. Secondly, the determination of the maximum output is possible by comparing the performance of private efficiency of use of resources of the enterprise with those of other companies and building a so-called “data envelopment” method of linear programming. Data envelopment defines the boundary of production capacity, i.e., the maximum possible output at any combination of resources. The method is called data envelopment analysis (DEA).

The methodology of comparative effectiveness analysis was developed by Farell M. and developed by Coelli T. and Charnes A. [1–3]. Very few attempts were made to apply this method to the analysis of agricultural enterprises in Russia in works [4–5]. In this
An analysis of the data from livestock and crop farms into four groups, namely, cattle, swine, poultry, and other plant products. Livestock farms were divided into three groups, i.e., nurseries, cattle, and others. Then, crop farms were divided into five groups depending on the value of technical efficiency (TE), and the average profitability of the group was 72%. The share of households with TE less than 25% was 16.6%. The highest percentage of households (54.8) was within the boundaries of the TE of 25–50% and the total profitability of production was zero. By 2002, the share of households with 100% TE increased to 5.5%, but the profitability of producing the group of farms decreased to 16.3%. Production became unprofitable in both groups of farms with TE up to 50%, but the proportion of farms in these groups declined. Profitability of farms increased in 2008 compared to 2002, and in all groups it became positive. However, the proportion of farms with 100% TE and

Theoretical framework for the DEA. A fundamental parameter in DEA is efficiency, which is generally defined as the quotient from the division of the sum of all output parameters on the sum of all input factors. For each decision-making unit (DMU), in our case for the agricultural enterprise, the magnitude of the efficiency is determined and then a comparison of observations is performed. It is implemented using a linear programming method using different basic models and their variations. Effective units are determined on the basis of the DEA from the total number of considered agricultural enterprises by constructing an efficiency frontier and, for all the others, the measure of their inefficiency is assessed. Technical efficiency is calculated as a ratio of sum of price weighted performance of a company to the sum of price weighted of used resources.

Agricultural enterprise is 100% effective in the following cases:
—when none of the output parameters can be upgraded without increasing one or more input factors or reducing other output parameters;
—when none of the input factors can be reduced without reducing one or more output parameters or increasing other input factors.

The effectiveness of each household is determined by solving the optimization problem of linear programming. A number of computer programs that automate calculations based on these methodologies have been developed. We used the software named EMS [7].

In actual calculations, we use the resource-based model with constant returns to scale. Arable land on the farm, number of average per year workers, cost of fixed assets, current assets (material costs) take separately for livestock and crop production, and conventional livestock is taken are factors of production in the model.

Cost of sold crops, livestock, and nonagricultural activities was taken as the main output parameters.

Depending on the specialization (activities) of the household, the use of resources and the output of marketable products were significantly different and, because of that, a preliminary grouping of all agricultural organizations by their specialization was held. Grouping was performed using actual data on the structure of commodity products. Initially, all of the farms were divided according to their dominance in the commodity production (over 50%) in three groups, i.e., nurseries, cattle, and others. Then, crop farms were divided into three groups, i.e., those with a predominance of the proceeds from the sale of grain and industrial crops, of potatoes and vegetables, and of other crop products. Livestock farms were divided into four groups, namely, cattle, swine, poultry, and other.

The used calculation software (EMS) is limited by the number of incoming objects (1000 units) In this regard, for areas in which the number of farms exceeds the limit, a set of objects for the calculations was determined by a random sampling. Furthermore, regardless of the original number of companies, the method of random sampling was built so that the sample size roughly corresponded to the maximum value.

The calculations of the relative effectiveness of farms were conducted for each group separately. To map the distribution by efficiency in dynamics, calculations were carried out for 1995 (the year the agricultural reforms began), 2002, and 2008.

The results of calculations. Value of indicators of the technical performance was obtained as a result of the calculations for each enterprise. For the analysis all farms were divided into five groups depending on the value of technical efficiency. The first four groups included farms, for which the calculated value was less than 100%, and the fifth group consisted of farms, for which the value was 100%, i.e., who made the DEA. In all selected groups, profitability and the amount of revenue attributable to group farms, one average employee, 100 hectares of arable land, and 100 rubles value of fixed assets were calculated. All calculations are shown in Tables 1–5 in accordance with the preferred direction of production activity.

A comparative analysis of the data in the tables has shown that the technical and economic efficiency of production activities of farms (profitability) have a positive relationship. Thus, all of the economic indicators in the table increase as you move from one group of technical efficiency to another and from one year to another. Therefore, if we take into account that, in general, during the considered periods, the profitability and revenue per unit of resource in farms tended to increase; then their technical efficiency also increased correspondingly. Thus, the signals of the emerging market influenced the improvement of production and competitiveness of enterprises.

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Plant-growing farms. An analysis of the data from Table 1 shows that, in 1995, only 3.7% of households of grain growing direction had 100% technical efficiency (TE), and the average profitability of the group was 72%. The share of households with TE less than 25% was 16.6%. The highest percentage of households (54.8) was within the boundaries of the TE of 25–50% and the total profitability of production was zero. By 2002, the share of households with 100% TE increased to 5.5%, but the profitability of producing the group of farms decreased to 16.3%. Production became unprofitable in both groups of farms with TE up to 50%, but the proportion of farms in these groups declined. Profitability of farms increased in 2008 compared to 2002, and in all groups it became positive. However, the proportion of farms with 100% TE and