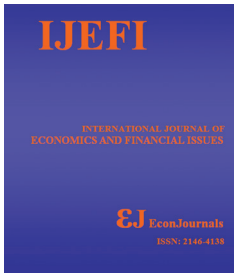

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Identification of the Factors of Sustainable Development of Regional Agricultural Systems using Regression Model

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ABSTRACT

The study is aimed at providing a theoretical basis for the relevance of sustainable development of regional agricultural systems and the development of practical recommendations for the implementation of the algorithm evaluation of the factors affecting the condition of agricultural production at the regional level. The study uses a systematic approach, supplemented with multifunctionality paradigm of agricultural production, which has enabled to develop an algorithm that includes a series of steps aimed at creating a regression model that reflects the significance of selected factors and their impact on the development of regional agricultural system. The developed method is tested in a study of rural areas of the Penza region, situated in the Central European part of Russia. The proposed indicators of sustainable development of regional agricultural systems are able to objectify the process of further evaluation of the spatial inhomogeneity of the factors determining sustainability of the agricultural production. The research findings provide additional opportunities in the agricultural development of the region.

Keywords: Sustainable Development Factors, Agricultural System, Rural Areas, Regional Development, Regression Model
JEL Classifications: r11, o13

1. INTRODUCTION

At the present stage of development, the characteristics of globalization and dynamism are inherent socio-historical process, which, on the one hand, help to enhance economic growth, and on another - entail uncertainty and instability of the development acting as destabilizing factor that substantially complicates the management of production systems. The growing influence of globalization makes the problem of transition to a model of sustainable development becomes particularly acute, causing an increased interest of both domestic and foreign scientists.

Given that the subject of research is the regional agricultural system, the research methodology is based on a systems approach (Tait and Morris, 2000). Supporters of this approach, while revealing the essence of the studied categories, consider the sustainable agricultural system, including regional, as an ability to consistently function and develop in the long term in a context of rapidly changing internal and external environment. These circumstances not only reinforce the need for regional studies, but also give them a special urgency in the context of issues of sustainability of agricultural development.

2. SUSTAINABLE DEVELOPMENT AND REGIONAL AGRICULTURAL SYSTEMS

Historically, agriculture in Russia plays a significant role in the development of agrarian regions and territories, as is still the main type of employment and source of income for rural residents. This fact puts the agricultural and agri-food sector at the heart of rural development based on the following principles (Van der Ploeg et al., 2000):

- Agricultural and agri-food sector is capable of generating processes of renewal of rural areas.

- Agriculture can compete with other sectors to attract resources, due to lower transaction costs and the costs of transformation (i.e., change).
- Paying attention to the flow of internal resources, the productive use of technology and the diversification of production towards new markets.

This approach, which prevailed in the first half of the 1980s (Murdoch and Pratt, 1993), examines the development of agricultural systems through the process of modernization of the agricultural sector. The areas of modernization differ and vary according to the needs of the sector, from historical and socio-economic conditions, to the evolution of markets and trade relations.

The development of agriculture in turn can stimulate great development processes in rural areas, since this does not happen by transferring resources to other sectors of the economy, but on the basis of preserving and improving the quality of existing resources. However, a similar effect can be achieved only if the following two conditions are met. Firstly, the agriculture is strongly integrated into the local economy and society (Smith and McDonald, 1998); secondly, the agriculture is able to have a positive impact on the local economy, in particular, on the development of competition and social relationships at the local level via strong integration ties (Van der Ploeg et al., 2002).

In recent decades, the representatives of different theoretical trends pay great importance to an objective assessment of the factors affecting the development of agricultural systems (OECD, 2001; Wascher, 2000). However, most of the proposed indicators focus only on environmental factors, while the socio-economic characteristics of sustainable agriculture are not taken into account. In addition, not all indicators are useful for the study of agricultural production and rural areas in specific Russian conditions.

The concept of concept of sustainability being developed and adopted on a global scale, demands simultaneous harmonization of the following subsystems in relation to agriculture:

- Agronomic, maintaining the productivity of agricultural land and arable land in the long run.
- Environmental, reducing harm to the environment and the integrity of ecosystems.
- Social, improvement of living standards of the rural population on the basis of growth of its revenues, the development of social and cultural services.
- Micro-economic, the existence of possibilities for the agricultural enterprises to function for a long time as the basic economic unit.
- Macroeconomic, meet the demand of the internal market and ensure competitiveness on foreign markets.

Thus, agricultural systems as a set of agricultural production, rural areas and rural communities are considered to be stable if their functioning is accompanied by an increase in production efficiency, promotion in the development of social infrastructure of rural areas, support of biodiversity and regeneration of natural resources, while demonstrating the ability to perform social, economic and environmental functions in the present and in the future, both at national and regional level (Lewandowski et al., 1999).

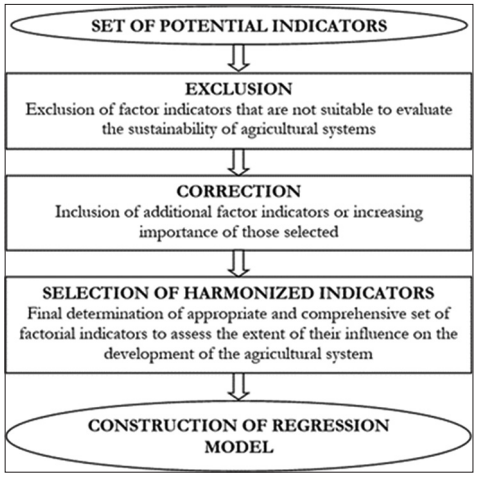
The main feature of agricultural systems is the multifunctionality (Morgan et al., 2010). In addition to the generally productive purpose, it is associated with providing many other services, such as nature conservation, resource management, improvement of social infrastructure, recreation. It is the versatility that is the basis of a new paradigm of sustainability, taking into account factors relating to the economic, social and environmental sustainability of rural development (Van Huylenbroeck and Durand, 2003). An important part in the concept of sustainability that takes into account the multifunctional nature of the agricultural sector occupies a regional uniqueness. Therefore, it is important to discover the factors that can cause changes in trends in the development of agricultural systems and increase the economic efficiency of municipalities.

The procedure for the selection of appropriate indicators of factors affecting the sustainable development of regional agricultural systems, involves the passage of several stages, shown in Figure 1. The resulting set of indicators can be used to build a regression model to assess the impact of the most important factors.

3. SUSTAINABILITY OF AGRICULTURAL SYSTEMS IN PENZA REGION

Traditionally the Penza region is references as one of agricultural regions of Russia located in the Central European part of the country. The agrarian production complex (APC) is one of the locomotives among the production sectors of the region economy. Looking at the gross regional product of the region, the share of agriculture is 9%. Agricultural lands make up to 3 million hectares of land, making it the eighth largest of the regions of Russia; including arable land of 51.6%. Agricultural lands are converted into a powerful raw material base having high potential for the development of a whole variety of types of agricultural products (Batova and Rassadin, 2014).

Figure 1: Algorithm of assessment of factors affecting the sustainability of agricultural systems



Analysis of the development of agricultural production in rural areas show the uneven distribution and the development of the agricultural sector, which is determined by a large number of simultaneous and cumulative effects of factors. In this regard, the need for a detailed study of the relationship between the volume of agricultural production in the municipalities of the Penza region (resulting variable y) on various factors (explanatory variables x_1, $x_{2,...}$ x_k) arises, which can be solved by using multiple regression analysis.

A preliminary step in the construction of multivariate regression model is the selection of the most important factors. Based on the analysis of statistical reports of municipalities in the form of 1-MO and municipalities' passports base (Rosstat, 2012), a total number of 30 indicators were selected in building the regression model (Table 1). The indicators selected based on the requirements of the Federal Methodology of complex assessment of the level of socio-economic development of the Russian Federation (RF Government Decree of 11.10.2001 N 717 'On the federal targeted program "Reduction of differences in socio-economic development of regions of the Russian Federation [2002-2010 and up 2015]").

For comparative evaluation and elimination of some factors in the program Statistica 6.0, a matrix of paired correlation coefficients is composed, which measures the closeness of a linear relationship of each factor to the effective sign with each of the other factor variables (Khalafyan, 2007). Between some of the factors a multicollinearity is found, which distorts the magnitude of the regression coefficients and complicates the process of determining the most significant factor variables. The reasons for its occurrence in is that factor features characterize the same aspect of the municipality development.

In order to eliminate the multicollinearity and to identify the most important factors, the method of exclusion of factors at the level of reliability was used, applying the 0.05 boundary. Using the regression coefficients shown in Figure 2 (column B), a multiple regression equation was built:

$$Y=-8{,}8142+36{,}5479\ V11 + 47{,}2857\ V7 + 5{,}4485\ V23 - 14{,}1383\ V20 + 0{,}0005\ V26 - 27{,}7257\ V2 + 62{,}1686\ V18$$

Checking the significance of individual regression coefficients performed by t-test shows that all the factors included in the model are significant, except for the factor 'number of seats in catering facilities' (V18). In order to increase the significance of the factor the level of reliability in assessing the significance is

Figure 2: Factor coefficients of the regression model derived from Statistika 6.0 program

N=27	Beta	Std.Err. of Beta	B	Std.Err. of B	t(19)	p-level
Intercept			-8,8142	5,70524	-1,54494	0,138854
V11	0,653191	0,119443	36,5479	6,68316	5,46865	0,000028
V7	0,598548	0,117457	47,2857	9,27920	5,09589	0,000064
V23	0,372646	0,117751	5,4485	1,72164	3,16469	0,005102
V20	-0,537299	0,124139	-14,1383	3,26657	-4,32819	0,000362
V26	0,292828	0,117265	0,0005	0,00019	2,49716	0,021871
V2	-0,356756	0,113154	-27,7257	8,79387	-3,15284	0,005239
V18	0,233407	0,130771	62,1686	34,83127	1,78485	0,090261

Table 1: Factors used in the construction of a regression models for assessing the development of regional agricultural system

Factor code	Factor title	Measures
Var 1	Land area of the municipality	Hectare per capita
Var 2	Investments in fixed assets from the municipal budget	Thousand rubles per capita
Var 3	Number of sports facilities	Units per 1,000 people
Var 4	Commissioning of residential buildings	Meter per capita
Var 5	Number of places in preschool for one child of preschool age	Places on person
Var 6	Number cultural institutions, such as leisure and library	Units per 100 people
Var 7	Number of health care institutions	Units per 100 people
Var 8	Number of hospital beds	Units per 100 people
Var 9	Number of doctors	Pers. per 100 people
Var 10	Number of nurses	Pers. per 100 people
Var 11	Length of road network	Thousand m2 per capita
Var 12	Length of the heating systems	Km per 100 people
Var 13	Length of the water supply network	Km per 100 people
Var 14	Length of sewage network	Km per 100 people
Var 15	Number of consumer service facilities	Units per 100 people
Var 16	Number of retail trade and catering facilities	Units per 1,000 people
Var 17	Trading floor space	Thousand m2 per capita
Var 18	Floor area of public catering	Thousand m2 per capita
Var 19	Number of seats in catering facilities	Units per 1,000 people
Var 20	Number of trading places on the market	Units per 1,000 people
Var 21	Tax revenues	Thousand rubles per capita
Var 22	Budget revenues from property	Thousand rubles per capita
Var 23	Own incomes of the budget	Thousand rubles per capita
Var 24	Spending on agriculture	Thousand rubles per capita
Var 25	Expenditures on social sectors	Thousand rubles per capita
Var 26	The share index of cadastral value of land	Rubles per hectare
Var 27	Unemployment rate	Percentage
Var 28	Overall criminality	Per 100 people
Var 29	Ratio of the average wage and the minimum subsistence level	Times
Var 30	Able-bodied population	Per capita

changed from 0.05 to 0.1, that is, the reliability of the model is, accordingly, not 95% but 90%. In this case, the model as a whole becomes significant. Using the calculation of Fisher's F-test, we determine that Frasch=9.81, and Fkrit=2.54 (table values). Since Frasch>Fkrit model is significant by the Fisher test.

The coefficient of determination of the chosen model is R2=0,787833, hence the factors included in the model to explain productive indicator by 78.33%.

There is a high impact on agricultural output by the number of health care institutions (V7), as the coefficient is equal to 47.2857. During the period of 2011-2014, the Penza region experienced an increase in provision of outpatient clinics per 10,000 population from 209.5 to 214.9 visits per shift, or 2.6% increase, which helps to keep the growth rate of agricultural production by reducing the length of stay of workers on sick leave and increase labor productivity.

One of the important indicators appears to be the floor area of public catering (V18), which creates certain social and living benefits for the area and satisfies the basic needs of the working population.

Reverse nature of the relationship observed between the sign and the effective factor for investments in fixed assets of APC from the municipal budget (V2), which, above all, reflects the low efficiency of use of funds at the local government level. At the same time, revealed the positive influence of the amount of own incomes of the budget (V23), as in accordance with the programs aimed at comprehensive development of rural areas, increasing the cost of social and infrastructural support of the population.

Reduction of the number of trading places on the market (V20), associated with the development of shopping centers in the cities and an increase in effective demand, stimulates the growth of agricultural production.

This statement is justified by the results of the 2014 sociological survey of private farms (a sample of 150 households) in three municipalities of the Penza region, selected on the basis of distance from the regional center. As can be seen from Table 2, the sale of products is carried out mainly through the intermediary buyers - 69%, who shift it to urban commercial network. Only approximately 38% of the commercial farms independently sell their products on the market.

Table 2: Distribution channels of commercial products by private farms

Distribution channels	Farmers and private farms, percentge
Market	38
Neighbors, own clients	45
Through agricultural consumer cooperatives	1
Through agricultural enterprise	0
To processing enterprises	1
To intermediary buyers	69
Other channels	1

The numerous problems related to the sale of products can be solved by the development of the market system and logistics centers at the level of cities and regions with large amounts of supplies, which will enable to increase agricultural production.

The indicator "length of road network" (V11), as a core element of engineering infrastructure, provides the territorial reach of rural communities and provides an opportunity to reduce the travel time of agricultural products.

In case of the legal framework for land market of agricultural land formed (V26, "The share index of cadastral value of land"), the revenues from leases can become the main asset of the rural economy, besides the agricultural products as additional means of replenishment of the local budget.

4. CONCLUSION

The indicators of sustainable development of regional agricultural systems being formed and offered for practical use in this study are able to objectify the process of further assessment the spatial inhomogeneity of the factors determining the sustainability of agricultural production economy. The analytic materials revealed open up additional opportunities in the agricultural development of the region.

Contemporary view of sustainability from the systemic approach, complemented by a paradigm of multifunctionality of agriculture, is an important basis for the development of targeted programs for the sustainable development of rural areas. Smoothing sharp differences at factor indicators and overcoming the crisis in the rural municipalities are not possible without public participation. The need to support rural areas is defined by the fact that they do not only ensure food security of the country, but are a major source of manpower for cities, a repository of national traditions and customs.

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