Development of the decision support system in the management of the agrarian sector in Russia

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Abstract: - Agriculture during the whole period of human civilization development is one of the most important branches of economy not only in Russia, but also in any other country, since this sector produces products vital for human activity. At the present time, the established fact is that agriculture is characterized by periodic fluctuations, which stretch for decades, existing as an independent phenomenon. This article presents an algorithm that allows managers to support the decision-making process in the management of the agricultural sector. This algorithm consists of four main stages, the result of its usage is the construction of three scenarios for the development of the agricultural sector: probable, optimistic and pessimistic. The construction of the development scenarios allows to neutralize the negative consequences and to enhance the opportunities.

Key-Words: - the agrarian sector, the rural areas, the entrepreneurship in rural areas, the simulation of development of the agricultural sector, support of the managerial decision-making in the agricultural sector, the method of Organization of economic cooperation and development, the filter of Hodrick-Prescott, the classification of indicators.

1 Introduction

The spatial structure of the Russian economy, in conditions of the market transformations, gives systemic failures, which are displayed at the level of the competitiveness of the territories. This situation is particularly relevant for the rural areas, the level of socio-economic development of which is much lower than in the cities. Even in a favorable external economic environment development of the Russian economy in the early 2000s, the number of depressed rural areas did not reduce, but even continued to grow. One of the main problems of the rural areas of modern Russia is poverty [1].

In the context of the research of the unemployment rate in Russia, it was revealed that the largest percentage of unemployment fell on the share of the rural population. In 2016, the unemployment rate of the rural population was 8.1%, which is 1.8 times higher than the unemployment rate in the city. And according to January 2017, this figure has already amounted to 9.1%, which exceeded the unemployment rate in the city twice [2]. This situation is explained by the fact that the labor market in the rural areas is built quite difficultly and has its own characteristics. It is characterized by the high labour intensity, rather low profitability, wages and the qualifications of the unemployed persons themselves [3].

Sustainable development of the rural areas, the solution of the social problems of the rural population is one of the main conditions of conflict-free, democratic development of the Russian society, its economic and social well-being and therefore it should become a priority direction of development of the state. In this regard, practical tools and mechanisms to ensure the competitiveness of the agricultural sector are necessary.

Currently, the stability and competitiveness not only of the individual enterprises, but also of the entire industries, regions and economies of the individual states, largely depend on their current information about the dynamics of the development of the cyclic processes occurring in them, as well as about the level of reliability of the data.

Increasing the level of reliability of information about the occurrence and proceeding of various scenarios of the system development is primarily required to understand the positive prospects and negative consequences of a scenario. It will allow to weigh the decisions and to react in time to changes that occur in the various spheres of human life. The process of supporting decision-making in the management of the agricultural sector of the Russian Federation requires, first of all, the definition of indicators that allow not only to model scenarios, but also to determine their main consequences [3].

2 Method of decision support in the agricultural sector of the economy

In order to effectively support the decision-making process in the management of the agricultural sector, it is necessary to:

- to select and classify indicators that will serve as a basis for the research;

- to select the main indicator for the development scenario;

- to build a script;

- to correct the constructed scenario, taking into account the experience gained for the previous periods.

Thus, the algorithm of the decision-making support in the management of the agricultural sector consists of the four stages.

Stage 1- the selection and classification of indicators. At this stage, a group of key indicators used to evaluate the selected system, and the selected indicators are classified into the groups: leading, matching and lagging.

The indicator classification algorithm is based on the Organization for economic co-operation and development (OECD) method, which is based on the idea of a benchmark that best reflects the dynamics of the system. In the developed algorithm, the basic indicator of the reference series is selected by an expert group, formed depending on the selected subject area and the level of its localization. On the basis of the selected indicator, a reference series is constructed, which serves as a basis for classifying the indicators into three groups.

According to the OECD method, the classification of indicators into groups: leading, matching and lagging – are carried out by applying the dynamics of the reference series and the dynamics of the classified indicator and comparing them.

The comparison is carried out as follows:

1) the points of the extremums of the reference series and the classified indicator are analyzed;

2) if the extremum points of the reference series and the classified indicator coincide, the indicator is considered to coincide;

3) if points of the extremums of a reference number come later, then at the classified indicator, the indicator is considered to be the leading one;

4) if points of the extremums of a reference number come earlier, then at the classified indicator, the indicator is considered to be the lagging.

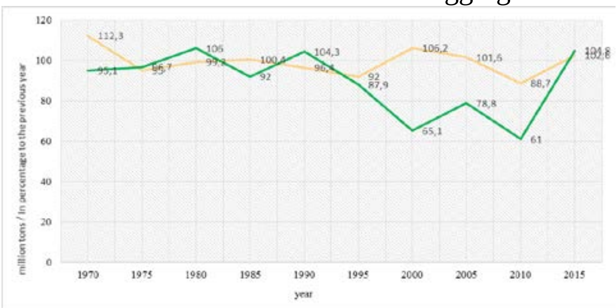

Fig. 1. Graphic comparison of the actual dynamics of the gross grain harvest and the reference series in the medium term.

After the classification procedure, the indicators are grouped into three groups: leading, matching and lagging.

An example of the results of the classification procedure is shown in table 1.

Table 1. The screen form of the program group of indicators, referred to the group «Leading»

An indicator	The advance	Number of significations	The degree of compliance
The energy capacities in the agricultural organizations, total, million	10	7	66
The entire cultivated area, thousand hectares	15	6	60
The entire cultivated area, thousand hectares	10	7	83
The entire cultivated area, thousand hectares	5	8	71
The application of the organic fertilizers for the crops in the agricultural organizations, million tons	15	6	60
The application of the organic fertilizers for the crops in the agricultural organizations, million tons	5	8	71
The gross grain harvest, million tons	10	7	83
The livestock, million heads	15	6	60
The milk production, million tons	15	6	60
The milk production, million tons	10	7	83
The production of the livestock and poultry for a slaughter (in a slaughter weight million tons)	10	7	66
The number of unprofitable enterprises, thousands	5	8	100
The average annual number of employed persons, thousands persons	15	6	80

To improve the reliability of the results of the development scenario from the group of leading indicators, the one that has the highest degree of the reliability is revealed, for this purpose, 2 stage – the filtration is introduced into the algorithm that supports the decision-making procedure.

Stage 2 – Filtration. The filtering process is based on the Hodrick-Prescott filter, which is:

1. smoothed series, which on the one hand, should be close enough to the original series, it is necessary to minimize the amount of deviation squares:

$$\sum_{t=1}^{T}(y_t - s_t)^2 \rightarrow min; \qquad (1)$$

2. on the other hand, the smoothed series should be sufficiently smooth that is, the series itself should be changed as smoothly as possible.

$$\sum_{t=2}^{T-1}\left((s_{t+1} - s_t) - (s_t - s_{t-1})\right)^2 \rightarrow min, \qquad (2)$$

The elements of the smoothed series are chosen so as to minimize the following expression:

$$\sum_{t=1}^{T}(y_t - s_t)^2 + \lambda \sum_{t=2}^{T-1}\left((s_{t+1} - s_t) - (s_t - s_{t-1})\right)^2 \rightarrow min$$

, (3)

where λ controls the smoothness of the series

– if λ = 0, St = y_t;

– if λ = 1, St = $const_t$;

For the different source data it is required to set different values of λ which are determined according to the analysed period. After calculations, we obtain the following results:

- for daily trend, λ = 43200;
- for the weekly trend, λ = 14400;
- for the month trend, λ = 1600;
- for the annual trend, λ = 100;
- for the two-year trend, λ = 4,5
- for the three-year trend, λ = 0.016
- for the four-year trend, λ = 0.00046
- for the five-year trend, λ = 0.00011

For the ten-year and five-year trend $\lambda \longrightarrow 0$, hence the formula

$$\lambda \sum_{t=2}^{T-1}\left((s_{t+1} - s_t) - (s_t - s_{t-1})\right)^2 \rightarrow 0 \qquad (4)$$

When you construct a composite leading indicator for the medium-term trend, the formula will look as follows

$$\sum_{t=1}^{T}(y_t - s_t)^2 \rightarrow min,$$

when y_t – a series of indicator;

s_t – the reference series.

The essence of the technique is that the difference between the points of the reference series and the points of the comparable indicator should be minimized.

Filter 1 $\sum_{t=1}^{T}(y_t - s_t)^2 \rightarrow min$

1) (112,3-95,1)2=295,84

The amount of the first filter is 3476.89

Filter 2

$$\sum_{t=2}^{T-1}\left((s_{t+1} - s_t) - (s_t - s_{t-1})\right)^2 \rightarrow min$$

The amount of the second filter 21964.8

2) ((106-96,7) - (96,7-95,1)) 2 = 59.29

Double filter

$$\sum_{t=1}^{T}(y_t - s_t)^2 + \lambda \sum_{t=2}^{T-1}\left((s_{t+1} - s_t) - (s_t - s_{t-1})\right)^2 \rightarrow min$$

.

For the five years is 0.00011

3) 3476,89+0,00011×8277,58=3475.2

In a similar way, a filtering operation is performed on the all selected indicators. After the filtering procedure, the indicators are smoothed according to the following formula:

$$\sum_{t=1}^{T}(y_t - s_t)^2 + \lambda \sum_{t=2}^{T-1}\left((s_{t+1} - s_t) - (s_t - s_{t-1})\right)^2 \rightarrow min$$

. The results of the smoothing indicators are presented in the table 2.

Table 2. The results of the smoothing procedure of the indicators.

№	An indicator	Filter 1	Filter 2	The filter of Hodrick-Prescott
1	The energy capacities in the agricultural organizations, total, million	365103,34	18675,54	365105,4
2	The entire cultivated area, thousand hectares	1,09673E+11	442295473	1,09673E+11
3	The application of the organic fertilizers for the crops in the agricultural organizations, million tons	326898,4	103773,75	326909,8
4	The gross grain harvest, million tons	3476,89	8277,58	**3475,20**
5	The livestock, million heads	22292,24	5034,58	22292,8
6	The production of the livestock and poultry for a slaughter (in a slaughter weight million tons)	87610,49	141,79	87610,5
7	The number of unprofitable enterprises, thousands	85174,51	1033,48	85174,6
8	The average annual number of employed persons, thousands persons	86391,51	123,71	86391,5
9	The milk production, million tons	35267,26	657,65	35267,3

Calculations, carried out on the example of the agricultural sector of the Russian Federation, showed that the minimum value of the distance between the points of the reference series and the indicator is achieved in the indicator "gross grain harvest", therefore, this indicator is the most reliable in the group of advanced in the medium term.

This indicator will be used to model scenarios for the development of the agricultural sector.

The schedule of dynamics of the gross grain harvest indicator will be used to construct scenarios for the development of the agricultural sector (fig. 2).

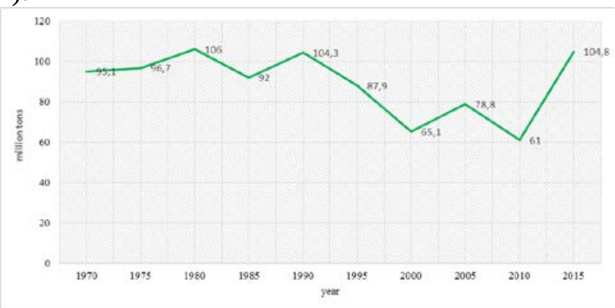

Fig. 2. Dynamics of the indicator «Gross harvest of grain».

As it can be seen from figure 2 in the medium term, the phases of recession and recovery are 5-10 years, the main phases of the development of the agricultural sector in the medium term, as well as the duration of their proceeding are presented in the table 3.

Table 3. The development phases of the agricultural sector in the medium term

Growth phase	From 1975 till 1985 years
Recession phase	From 1985 till 1995 years
Growth phase	From 1995 till 2000 years
Recession phase	From 2000 till 2010 years
Growth phase	From 2010 till the present time

After selecting the leading indicator and graphing its dynamics, the decision support algorithm provides for the third stage - the construction of the perspective dynamics of the development of the agricultural system. The most appropriate leading indicator is shown in table 4.

Table 4. The most appropriate leading indicator

An indicator	The advance	Number of sognifications	The degree of compliance
The gross grain harvest, million tons	10	7	83

The reference series

To correct the possible deviation of the actual scenario from the simulated one, the algorithm provides for 4 stages – the process of the building the confidence interval of the scenario deviation, which is determined on the basis of the previous experience. Table 5 presents the calculation of the confidence interval of the scenario for the development of the agricultural sector, which will be used to build the optimistic and pessimistic scenarios for the development of the agricultural sector in the medium term.

The confidence interval is required to be constructed to estimate the mathematical expectation at an unknown value of the standard deviation from the normally distributed population.

It is required to find a quantity $t_{\alpha,n-1}$ for which equality is true

$$P\left(\bar{X}-\frac{s}{\sqrt{n}}t_{\alpha,n-1}<a<\bar{X}+\frac{s}{\sqrt{n}}t_{\alpha,n-1}\right)=1-\alpha \quad (5)$$

In this formula:

$\bar{X}$ –the arithmetic signification
S - standard (standard square) deviation
n - number of years

α - the value in the amount of confidence giving 1 (in our case 0.05).

The value $t_{\alpha,n-1}$ (in our case $t_{0,05,9}$) is found on the student distribution tables. It is equal to 2.262.

Find the sample mean as the arithmetic average of

$$\bar{X}=\frac{1}{n}\sum_{i=1}^{n}x_i=99{,}48$$

Let's calculate the standard deviation through variance:

$$s^2=\frac{1}{n-1}\sum_{i=1}^{n}\left(x_i-\bar{X}\right)^2 \quad (6)$$

then $\frac{s}{\sqrt{n}}t_{\alpha,n-1}\approx 4{,}94$

The obtained values of the confidence interval

$$\bar{X}-\frac{s}{\sqrt{n}}t_{\alpha,n-1}=94{,}54;\ \bar{X}+\frac{s}{\sqrt{n}}t_{\alpha,n-1}=104{,}42$$

Table 5. The determination of the values of the confidence interval for a short period

An indicator	The signification
The arithmetic average	99,48
The dispersion	47,67
The standard deviation	6,9
The signification of the	4,94

definition of lower and upper bounds	
The lower limit signification	94,54
The upper limit signification	104,42

3 Problem Solution

Using the boundaries of the confidence interval, together with the extrapolation method, two additional scenarios of the agrarian sector in the medium term are constructed – the optimistic and pessimistic.

The optimistic development option is shown in the figure 3. It is expected that from 2010 to 2020 there will be growth, and then a decline from 2020 to 2030, from 2030 to 2035 it is growth, thereby repeating the period of development from 1975 to 2000.

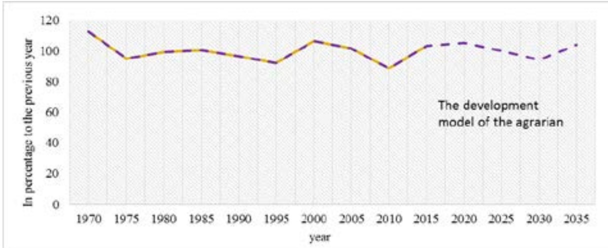

Fig. 3. Optimistic scenario of the agricultural sector development in the medium term.

The pessimistic development option is shown in the figure 4. It is expected that from 2015 to 2025 there will be a decline, and from 2025 to 2030 growth will begin.

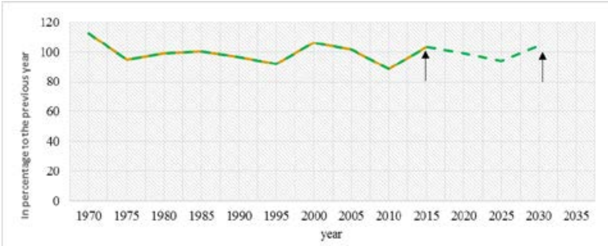

Fig. 4. Pessimistic model of the agricultural sector development in the medium term.

The imposition of the optimistic, pessimistic and modelled scenarios allows managers of agricultural enterprises to develop options for development strategies and to monitor the implementation of a scenario based on the dynamics of coinciding indicators (fig. 5) [6].

The scenarios for development of the lagging indicators will determine the possible consequences of the occurrence of a scenario, which makes it possible for the management team to develop complexes of different solutions.

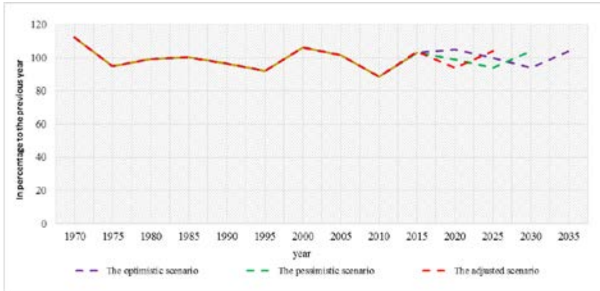

Fig. 5. Options for the development of the agricultural sector in the medium term.

4 Conclusion

The algorithm developed by the authors can be used in the decision-making process when coordinating the conditions of the agreement on agriculture within the framework of the rules of multilateral agreements of the WTO, affecting all areas of the socio-economic system of the country.

And also with regards of coordination of the following important aspects of the WTO on agriculture, first of all, coordination of the opportunities of access to the Russian market concerning questions of forming of the rates of customs duties, the level of the tariff quotas and application of the special protective measures registered in the agreement on agriculture. Secondly, the issues affecting the domestic support for agriculture – the so-called" boxes " - green, yellow and blue, as well as the aspects such as the so-called deminimus. Thirdly, the usage of the sanitary and phytosanitary measures. Fourthly, the regulation of the services and, first of all, the veterinary services. All the above mentioned aspects also have a significant impact on the decision-making in the management of the agricultural sector. Depending on the format of the cooperation within the framework of this Agreement, both optimistic and pessimistic influence on the development of the agricultural sector in the medium term is possible. However, the import-substituting vector will allow to neutralize the pessimistic influence to a greater extent and to be able to reach a long-term positive trajectory.

The algorithm that supports the decision-making process will improve the efficiency of management in the business sector of agriculture [5]. Given the availability of the sufficient entrepreneurial potential in the rural areas (the entrepreneurship in rural areas is sometimes the only way of existence and survival), the necessary incentives for the growth of the entrepreneurial activity are either low or simply absent in a number of regions. Motivation of the entrepreneurial activity in the rural areas is constrained by problems objectively existing in the real life. In this situation, financial incentives should be a key component of motivation, since the standard of living in the rural areas is quite low and this is a major reason for the outflow of population from rural areas. Motivation of management in rural areas is possible in the process of increasing the level of the economic education of the management of business entities. At the present time many entrepreneurs in rural areas do not possess economic knowledge in amounts sufficient for the effective entrepreneurial activity. As motivational directions it is also possible to allocate: decrease in the expenses on the recovery actions, creation of the favorable environment of accommodation of the agricultural entrepreneur and his family, the solution of the personnel problems of the rural territory. Given the importance of the material component in the motivational guidelines for the development of agribusiness, it is necessary to strengthen the mechanism of social partnership as a starting point. Thus, the additional instrumental support of the decision-making process of the entrepreneur in the management of agricultural production will increase his motivation for the independent activity by reducing the level of risk.

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