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TRENDS AND OPPORTUNITIES FOR GROWTH OF AGRO-INDUSTRIAL PRODUCTION IN THE REPUBLIC OF KAZAKHSTAN

ҚАЗАҚСТАН РЕСПУБЛИКАСЫНДАҒЫ АГРОӨНЕРКӘСІПТІК ӨНДІРІСТІҢ ӨСУ ТРЕНДТЕРІ МЕН МҮМКІНДІКТЕРІ

ТРЕНДЫ И ВОЗМОЖНОСТИ РОСТА АГРОПРОМЫШЛЕННОГО ПРОИЗВОДСТВА В РЕСПУБЛИКЕ КАЗАХСТАН

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Abstract. *Goal* – modern popular models for development of agro-industrial production are proposed, which are based on factors reflecting current and potential directions of innovative activity in agricultural industry of the Republic of Kazakhstan. In the process of preparing the article, a wide range of general scientific and specific scientific *methods* was involved: generalization of theoretical approaches, comparative analysis, system-dynamic and economic-mathematical modeling, trend analysis method, dialectical. The theoretical and methodological basis was provided by fundamental developments of domestic and foreign scientists on issues of innovation policy in agro-industrial complex of the republic. *Results* - the current state of agricultural sector has been studied, including main trends and problems of introducing modern technological and organizational innovations used in agriculture in Kazakhstan. The factors that have significant impact on increasing competitiveness of agricultural sector are analyzed. Forecasts for structural restructur-

ing of production, increasing the level of investment, etc. are presented. Practical recommendations for stimulating innovative activity in agro-industrial complex are given, taking into account its characteristics. The following competencies of agro-industrial complex are defined as basic: creating food potential, ensuring structural and sectoral balance of national economic system, forming technological platform. *Conclusions* - further growth in the volume of gross output of economic entities is possible in the conditions of significant financial investment in environmental protection, scientific research that contributes to production of environmentally friendly products and increase in GDP in the industry. In general, over the past years, the situation in Kazakhstan's agriculture has been stabilizing, which is manifested in strengthening of financial and economic position of large and medium-sized agricultural enterprises.

Аңдатпа. *Мақсаты* – Қазақстан Республикасының ауыл шаруашылығы саласының инновациялық қызметінің ағымдағы және әлеуетті бағыттарын көрсететін факторлар негізінде агроөнеркәсіптік өндірісті дамытудың қазіргі заманғы сұранысқа ие модельдері ұсынылған. Мақаланы дайындау барысында жалпы ғылыми және нақты ғылыми *әдістердің* кең спектрі қолданылған: теориялық тәсілдерді жалпылау, салыстырмалы талдау, жүйелік-динамикалық және экономикалық-математикалық модельдеу, трендтік талдау әдісі, диалектикалық. Республиканың АӨК-дегі инновациялық саясат мәселелері бойынша отандық және шетелдік ғалымдардың іргелі әзірлемелері теориялық-әдіснамалық негіз болды. *Нәтижелері* – Қазақстанның ауыл шаруашылығында пайдаланылатын заманауи технологиялық және ұйымдастырушылық инновацияларды енгізудің негізгі үрдістері мен проблемаларын қоса алғанда, аграрлық саланың ағымдағы жағдайы зерттелген. Аграрлық сектордың бәсекеге қабілеттілігін арттыруға елеулі әсер ететін факторлар талданды. Өндірісті құрылымдық қайта құру, инвестициялау деңгейін арттыру және т.б. болжамдар ұсынылған. Оның ерекшеліктерін ескере отырып, агроөнеркәсіптік кешендегі инновациялық белсенділікті ынталандыру бойынша практикалық ұсыныстар берілген. Базалық ретінде АӨК-нің мынадай құзыреттері айқындалған: азық-түлік әлеуетін құру, ұлттық экономикалық жүйенің құрылымдық-салалық теңгерімін қамтамасыз ету, технологиялық платформаны қалыптастыру. *Қорытындылар* – шаруашылық жүргізуші субъектілердің жалпы өнімі көлемінің одан әрі өсуі экологиялық таза өнім алуға және салада ЖІӨ-нің ұлғаюына ықпал ететін қоршаған ортаны қорғауға, ғылыми зерттеулерге қомақты қаржы қаражатын салу жағдайында мүмкін болады. Жалпы, соңғы жылдары Қазақстанның ауыл шаруашылығындағы ахуал тұрақтануда, бұл ірі және орта ауыл шаруашылығы кәсіпорындарының қаржылық-экономикалық жағдайын нығайтуда көрінеді.

Аннотация. *Цель* – предложены современные востребованные модели развития агропромышленного производства, на основе факторов, отражающих текущие и потенциальные направления инновационной деятельности сельскохозяйственной отрасли Республики Казахстан. В процессе подготовки статьи был задействован широкий спектр общенаучных и специфических научных *методов*: обобщение теоретических подходов, сравнительный анализ, системно-динамическое и экономико-математическое моделирование, метод трендового анализа, диалектический. Теоретико-методологической основой послужили фундаментальные разработки отечественных и зарубежных ученых по вопросам инновационной политики в АПК республики. *Результаты* – исследовано текущее состояние аграрной сферы, включая основные тенденции и проблемы внедрения современных технологических и организационных инноваций, используемых в сельском хозяйстве Казахстана. Проанализированы факторы, оказывающие существенное влияние на повышение конкурентоспособности аграрного сектора. Представлены прогнозы структурной перестройки производства, повышения уровня инвестирования и др. Даны практические рекомендации по стимулированию инновационной активности в агропромышленном комплексе, учитывая его особенности. В качестве базовых определены следующие компетенции АПК: создание продовольственного потенциала, обеспечение структурно-отраслевого баланса национальной экономической системы, формирование технологической платформы. *Выводы* – дальнейший рост объемов валовой продукции хозяйствующих субъектов возможен в условиях вложения значительных финансовых средств в охрану окружающей среды, научные исследования, способствующих получению экологически чистой продукции и увеличению ВВП в отрасли. В целом в течение последних лет ситуация в сельском хозяйстве Казахстана стабилизируется, что проявляется в укреплении финансово-экономического положения крупных и средних сельскохозяйственных предприятий.

Key words: agricultural sector, modeling, trend model, innovative development, technological science, environment, environmentally friendly products, food potential.

Түйінді сөздер: аграрлық сектор, модельдеу, тренд моделі, инновациялық даму, технологиялық ғылым, қоршаған орта, экологиялық таза өнімдер, азық-түлік әлеуеті.

Ключевые слова: аграрный сектор, моделирование, трендовая модель, инновационное развитие, технологическая наука, окружающая среда, экологически чистые продукты, продовольственный потенциал.

Introduction

Relevance. The current stage of transformation of agrarian relations is characterized by the transition from an inertial to an innovative development model, which provides for the systematic integration of the scientific and technical sphere of the agro-industrial complex in order to increase the economic efficiency of production. Widespread innovation is becoming a key factor in the growth of production and employment in agriculture.

Strengthening innovative initiatives in agriculture of the domestic agro-industrial complex of the country is a key area of strategic development and economic progress of the state. The introduction of innovative approaches in the agricultural sector also contributes to improving the country's food security (Ob utverzhdenii nacional'nogo proekta …) [1].

The agricultural sector, as an important industry with socio-economic and economic impact, requires systematic innovation. In Kazakhstan, the issue of developing an innovative model in the agricultural sector based on the principles of sustainable development remains a priority and requires constant additional theoretical and methodological analysis with an assessment and definition of organizational and economic measures to address it.

However, to date, no effective mechanism has been created to encourage innovative activity in the agribusiness of the regions of Kazakhstan using modern methods and economic incentives. The development of the concept of innovative development of agribusiness in the regions is one of the most urgent and difficult tasks in the field of agricultural science. This concept should clearly define the composition and nature of the scientific and technical aspects of agricultural production, substantiate the directions and forms of real innovations in this area, and also take into account the institutional foundations of this development, taking into account the peculiarities of agrarian relations in each particular region.

In the context of acute market competition and the difficult economic situation in agriculture, the strategy of innovative production development should replace outdated economic methods.

Therefore, the task of this study was to identify the main trends and problems of innovative development of the agricultural sector, as well as to forecast the development of the industry based on the development of a trend innovation model.

Hypothesis. The trend innovation model can be an effective tool for formulating development strategies, making informed decisions and long-term investment planning in agricultural production.

Literature Review

The advanced concept of an innovative economic model was developed taking into account the fundamentals of the ideology of sustainable development. In the agricultural sector, it was developed on the basis of a scientific analysis of the basic principles of the activities of organizations and systems aimed at meeting growing needs and increasing labor productivity (Zhangirova R.N.); (Grigor'eva I. A.) [2, 3]

Both domestic and foreign economists paid active attention to the problems of developing an innovative development strategy in various periods. So, according to the research of Academician Ushachev I., the development of innovations in the agricultural sector is based on the main three interrelated areas of innovation: human, biological and technological factors (Ushachev I.G., Maslova V.V., CHekalin V.S.) [4]

One of the strategic tasks in the implementation of Industry 4.0 is to study the issues of digital transformation of SME production and provide them with the appropriate tools for implementation in practice (Matt D., Rauch E.) [5] In the context of innovative development, an important role is assigned to human capital, which influences the overall quality management in the high technology sector (Houneida B., Slim H.) [6]

Scientists such as G.A. take an active part in scientific research devoted to issues of the agro-industrial complex and innovative development of agriculture in Kazakhstan. Kaliev G., Kenzhebolatova M., Moldashev A.B., Kaygorodtsev A.A. and others. Issues and problems related to the formation of sustainable development of agriculture are studied by scientists: Satybaldin N.K., Saparova, S. Seitzhanov G.K., Zhangirov R.N. and others.

Agricultural transformation includes various changes such as the introduction of new technologies, sustainable farm management, problem management and changes in consumer demand. These innovations have a significant impact on all spheres of the economy, which is reflected by changes in the nature of work, the role of mental and creative functions is increasing, which requires advanced training of workers, including those in the agricultural sector (Seitzhanov S., Kurmanov N., Petrova M.) [7].

In the works of Professor Saparova G.K. the impact of digitalization on the development of the agricultural sector of Kazakhstan is explored, and prospects for the development of Kazakhstan in the context of a "green economy" are presented. (Saparova G.K., Saparova D.A., Saginova S.A.) [8].

However, issues related to the specifics of innovation processes in agriculture have not yet been sufficiently studied, especially at the stage of dissemination and implementation of innovations, as well as in the context of increasing the efficiency and directions of state support for innovations in the agricultural sector, which requires further study.

Materials and methods

The research is based on the theoretical and methodological principles of modern economic theory, statistical data from the Bureau of National Statistics Agency for Strategic Planning and Reforms of the Republic of Kazakhstan, as well as scientific works by leading domestic and foreign scientists dealing with issues of innovative transformations in the current context of modern challenges of global sustainable development.

In the process of research, the following general scientific and special scientific methods such as theoretical generalization, comparative analysis, system-dynamic modeling, dialectical, etc., were used.

The assessment of current state of agricultural production is based on statistical data, which include information on the areas of providing information support for economic activity, institutional aspects of functioning of territorial and economic entities, as well as sectoral features of gross product formation in agricultural production. We use trend method of analyzing agricultural production as economic and mathematical research framework.

The trend method allows to gain deep understanding of long-term changes in agricultural production and can be useful for developing development strategies, decision making and planning long-term investments (Grigor'eva I. A.) [3].

Results

The introduction of innovative solutions in the agricultural sector is characterized by diversity and vastness. For example, in the production of soft wheat varieties, more efficient technologies for deep grain processing, an increase in feed production, and an expansion of grain crops in the most suitable soil and climatic zones can be used.

The use of intensive technology, taking into account all methods of agricultural technology, will make it possible to obtain high-protein grain of durum wheat with a yield of at least 16–18 c/ha. It is important that government support measures are targeted and funds distributed in accordance with the recommended sown areas for priority crops.

Analysis of statistical data shows that efficient distribution of production combined with the use of technologies aimed at saving resources will allow to achieve profitability level of at least 34–35%. The introduction of intensive methods of durum wheat cultivation, increase in sown areas to 450 thousand hectares, optimal combination of varieties with different growing seasons, the use of high-quality and highly productive seeds, as well as increase in public financial support and other factors will ensure increase in yield to 14 c/ha (or 51 .8%) (Bjuro nacional'noj statistiki Agentstva….) [9].

One of the goals of our research is to analyze and generate forecast data on long-term trends in the development of agriculture in Kazakhstan, for this purpose, the trend analysis method of agricultural production was used. This method allows to assess changes in key indicators of agricultural sector over a long period of time and identify the main trends that may influence on its development. The main steps of the trend method include (Suieubayeva S., Gola A., Zakimova A.) [10]:

- data collection: collection of input data on various aspects of agricultural production, such as production volumes, costs, profitability levels, sown areas, level of technological equipment and other key indicators;
- data cleaning: analysis and cleaning of data from possible outliers, errors or anomalies that could distort the results of the analysis;
- graphing and charting: use of visualizations such as line graphs or charts to show long-term changes in selected metrics;
- trend identification: the use of statistical methods, such as linear extrapolation and linear regression methods, to determine trends and rates of increase or decrease in selected indicators;

- analysis of the causes of changes: assessment of factors that may influence on the detected trends, such as changes in legislation, technological innovations, climatic conditions, etc.;

- forecasting: based on the identified trends, one can try to make forecasts regarding the future development of agricultural sector.

To carry out calculations, we will use time series data of the factors under study for the period 2017-2022, presented in table 1.

Let us analyze the data using the proposed economic-mathematical method in order to identify patterns in changes in the process under consideration, using the example of forecasting the indicators under study.

Based on the analysis of correlation coefficient, it can be assumed (for the full sampling) that there is a linear relationship between all possible values of the variables *t* and *y*. The trend model equation is expressed as follows: $y = b\,t + a$

The estimating equation of trend model (constructed from sample data) will have the form (Suieubayeva S., Gola A., Zakimova A.) [10]:

$$y = b\,t + a + \varepsilon \qquad (1)$$

where

ε – observed values (estimates) of errors ε_i, *a* and *b*, respectively, estimates of parameters α and β of the trend model that should be found.

To estimate the parameters α and β - the LSM (least squares method) is used.

Table 1 – Factor signs of influence on development of agricultural production in the Republic of Kazakhstan for the period 2017-2022.

Agricultural production indicators	2017	2018	2019	2020	2021	2022
Gross crop production, million tenge	1 713 454,2	2 411 486,7	2 817 660,6	3 687 310,3	4 387 236,5	5 808 259,8
Gross livestock production, million tenge	1 852 404,7	2 050 455,8	2 319 496,7	2 637 460,7	3 116 973,5	3 658 757,6
Services in the field of agriculture, million tenge	11 911,6	12 145,6	14 005,7	9 897,9	11 223,4	14 162,5
Level of profitability (unprofitability) of agricultural production in agricultural enterprises of the RK, in %	28,2	31,1	34,2	39,6	37,8	44,9
Level of profitability (unprofitability) of livestock production in agricultural enterprises of the RK, in %	20,4	19,7	22,0	21,1	17,2	18,8
Specified sown area of agricultural crops for all categories of farms, thousand hectares	20 546,4	21 899,4	22 135,8	22 582,3	22 925,7	23 162,1
Rural housing stock, total area of housing, at the end of the year, million sq. m. m	127 332	130 297	132 877	134 494	137 481	141 237
Note: compiled on the basis of data from the Bureau of National Statistics of the Agency for Strategic Planning and Reforms of the Republic of Kazakhstan						

The least squares method provides the best (consistent, efficient, and unbiased) estimates of the parameters of trend model equation. But only if certain premises are met regarding the random term (ε) and independent variable (*x*). (Соловьева Н.А., Кондратенко Л.Н., Емельянов Д.О.) [11]

Formally, the LSM criterion can be written as follows:

$$S = \sum (y_i - y^*{}_i)^2 \to min \qquad (2)$$

To calculate trend model parameters, we will build a calculation table 2.

System of normal equations.

$$\begin{cases} a \cdot n + b \cdot \sum t = \sum y \\ a \cdot \sum t + b \cdot \sum t^2 = \sum y \cdot t \end{cases} \qquad (3)$$

For our data, system of equations has the form

$$\begin{cases} 6 \cdot a + 21 \cdot b = 20825408{,}05 \\ 21 \cdot a + 91 \cdot b = 86524391{,}85 \end{cases} \qquad (4)$$

Solving the system using algebraic addition method, we will obtain empirical coefficients of trend model:

a = 743808,607, *b* = 7791169,353

Trend model equation:

$y = 7791169{,}353 \cdot t + 743808{,}607$ (5)

The empirical coefficients *a* and *b* are only estimates of theoretical coefficients *βi*, and the equation itself reflects only general trend in behavior of variables under consideration.

Table 2 - Calculation table of equation parameters

t	y	t^2	y^2	t × y
1	1713454,15	1	2935925124152,2	1713454,15
2	2411486,7	4	5815268104276,9	4822973,4
3	2817660,6	9	7939211256792,4	8452981,8
4	3687310,3	16	13596257248486	14749241,2
5	4387236,5	25	19247844106932	21936182,5
6	5808259,8	36	33735881904296	34849558,8
21	20825408,05	91	83270387744936	86524391,85
Mean value	3470901,34	15,167	13878397957489	14420731,98
Note: compiled by the authors based on calculations				

Let's analyze the parameters of trend model equation:

1. Calculate the standard deviation:

$$S(y) = \sqrt{S^2(y)} = \sqrt{90778898969{,}556} = 301295{,}3683 \quad (6)$$

$$S_b = S_y \cdot \frac{\sqrt{S_y^2}}{n\sigma_t} = 301295{,}3683 \cdot \frac{\sqrt{91}}{6 \cdot 1{,}7078} = 280490{,}723 \quad (7)$$

$$S_a = \frac{S_y}{\sqrt{n}\sigma_t} = \frac{301295{,}3683}{1{,}7078\sqrt{6}} = 72023{,}369 \quad (8)$$

Let us calculate determination coefficient:

The square of (multiple) correlation coefficient is called the determination coefficient, which shows proportion of variation in result attribute explained by variation in factor attribute (Нгуен Т., Кравец А., Зыонг Х.) [12]

Most often, when interpreting determination coefficient, it is expressed as a percentage.

$$R^2 = 1 - \frac{\sum(y_i - y_t)^2}{\sum(y_i - \bar{y})^2} = 1 - \frac{363115595878{,}22}{10987451003435} = 0{,}967 \quad (9)$$

i.e., in 96.7% of cases, changes in t lead to changes in y. In other words, the accuracy of selecting trend equation is high.

To assess the quality of equation parameters, we will construct a calculation table 3.

Table 3 - Calculation table for assessing quality of trend equation parameters

t	*y*	*y(t)*	$(y_i - y)^2$	$(y_i - y(t))^2$
1	1713454	1522977,96	3088620631497,1	36281179138,322
2	2411487	2302147,312	1122359382977,7	11955101684,908
3	2817661	3081316,665	426723466573,22	69514520736,835
4	3687310	3860486,018	46832837246,918	29989829337,802
5	4387237	4639655,371	839670122397,78	63715286412,875
6	5808260	5418824,724	5463244562742,4	151659678567,48
7		20825408,05	10987451003435	363115595878,22
Note: compiled by the authors based on calculations				

Let's calculate the interval forecast:

Let's determine the root mean square error of the predicted indicator.

$$U_y = y_{n+L} \pm K \quad (10)$$

$$K = t_a \cdot S_y \cdot \sqrt{1 + \frac{1}{n} + \frac{3(n+2L-1)^2}{n(n^2-1)}} \quad (11)$$

where L - lead period;

y_{n+L} - point forecast according to model at (n + L) point in time;

n - number of observations in the time series;

Sy - standard error of predicted indicator;

T_{table} - table value of the Student's test for the significance level α and for the number of degrees of freedom equal to *n*-2.

Using the Student's table we find T_{table}.

T_{table} (n – m – 1; α/2) = (2; 0,05) = 3,495 (12)

Point forecast, t = 7:

y(7) = 779169,353×7 + 743808,607 = 6197994,08

$$K_1 = 3{,}495 \cdot 301295{,}37\sqrt{1+\frac{1}{6}+\frac{3(6+2\cdot 1-1)^2}{6(6^2-1)}} = 1438709{,}2$$

Interval forecast:

Uy_1 = 6197994,08 – 1438709,2 = 4759284,88
Uy_2 = 6197994,08 + 1438709,2 = 7636703,28

Point forecast, t = 8:

y(8)=779169,353×8+ 743808,607 = 6977163,43

$$K_2 = 3{,}495 \cdot 301295{,}37\sqrt{1+\frac{1}{6}+\frac{3(6+2\cdot 2-1)^2}{6(6^2-1)}} = 1605239{,}73$$

Interval forecast:

Uy_1 = 6977163, 43 – 1605239,73 = 5371923,7
Uy_2 = 6977163, 43 + 1605239,73 = 8582403,21

Point forecast, t = 9:

y(9)=779169,353×9+743808,607=7756332,78

$$K_3 = 3{,}495 \cdot 301295{,}37\sqrt{1+\frac{1}{6}+\frac{3(6+2\cdot 3-1)^2}{6(6^2-1)}} = 1791768{,}01$$

Interval forecast:

Uy_1= 7756332,78 – 1791768,01 = 5964564,77
Uy_2=7756332,78 + 1791768,01 = 9548100,79

Let's test hypotheses regarding the coefficients of linear trend equation.

1. t-statistics. Student's t test.

Using the Student's table we find T_{table}

T_{table} (n – m – 1; α/2) = (4;0.025) = 3,495 (13)

$$t_a = \frac{a}{S_a} = \frac{778169{,}353}{72023{,}369} = 10{,}8183 > 3{,}495$$

The statistical significance of coefficient *a* is confirmed. The estimate of parameter *a* is significant and time series has a trend.

$$t_b = \frac{b}{S_b} = \frac{743808{,}6067}{280490{,}723} = 2{,}6518 < 3{,}495$$

The statistical significance of coefficient *b* is not confirmed.

2. F-statistics. Fisher criterion.

$$F = \frac{R^2}{1-R^2}\cdot\frac{n-m-1}{m} = \frac{0{,}967}{1-0{,}967}\cdot\frac{6-1-1}{1} = 117{,}0353 \quad (14)$$

We'll find table value Fkp (1; 4; 0.05) = 7.7086,

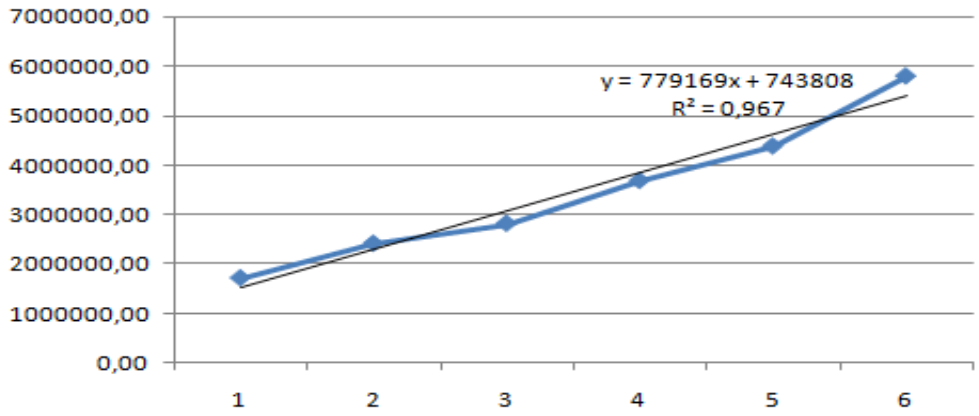
where m - number of factors in trend equation (m=1).

Since F > Fkp, determination coefficient (and trend equation as a whole) is statistically significant.

In the course of the study of trend model equation, time dependence Y on time t was studied. At specification stage, linear trend was chosen. Its parameters were estimated using the least squares method. The statistical significance of the equation was tested using the determination coefficient and Fisher's test. (Solov'eva N.A., Kondratenko L.N., Emel'yanov D.O.) [11]

Based on the calculations obtained, it was found that 96.7% of the total variability of the variable Y is associated with changes over time. But the statistical significance of the model parameters has not been confirmed. If we consider the interpretation of the model parameters from the economic side, we get the following dependence, with each time period t, the value of the calculated indicator "Gross crop production" (Y) increases on average by 779 169.353 million tenge.

Presentation of the study results of trend model of factor attribute "Gross crop production" in graphical form is shown in figure 1.



Note: compiled by the authors based on calculations

Figure 1- Gross crop production, million tenge

Further, according to the stated economic and mathematical method, study of the state of agricultural production of other factor indicators based on time series was carried out (table 4).

The developed models on the basis of which the forecast was made, with the obtained probability levels R^2, allow to assert that while maintaining the existing patterns of development, predicted value falls into the calculated value of identified trend in indicators (Nguyen, T.V., Kravets, A.G., Duong, Q. H.T.) [12].

Table 4 - Equations of trend models of predicted indicators for the period 2016-2022

Estimated indicator	Equation of trend model	Root-mean-sq, estimation error	Deter. Coefficient, r^2_{yx}	Fisher coefficient F-test
Gross crop production, million tenge	Yt = 743808,607 + 7791169,353 t	301295,3683	0,967	117,04
Gross livestock production, million tenge	Yt = 1350996,7 + 358550,897 t	140733,3352	0,966	113,59
Services in the field of agriculture, million tenge	Yt = 11786,42 + 125,15 t	1814,7894	0,721	6,08
Level of profitability (unprofitability) of agricultural production in agricultural enterprises of the RK, in %	Yt = 25,04 + 3,12 t	1,855	0,925	49,51
Level of profitability (unprofitability) of livestock production in agricultural enterprises of the RK, in %	Yt = 21,507 – 0,469 t	1,6425	0,463	1,42
Specified sown area of agricultural crops for all categories of farms, thousand hectares	Yt = 20548,227 + 474,397 t	349,442	0,891	32,25
Rural housing stock, total area of housing, at the end of the year, million sq. m.	Yt = 124683,6 + 2648.4 t	594,238	0,989	347,61
Note: compiled by the authors based on calculations				

Based on developed equations of trend models, forecast calculations were done for the remaining main statistical indicators characterizing the dynamics of development of agricultural production in the Republic of Kazakhstan (table 5).

Table 5 - Forecast values of projected indicators of agricultural production in the Republic of Kazakhstan for the period 2023-2025

Agricultural production indicators	2023	2024	2025
Gross crop production, million tenge	6 197 994,07	6 977 163,42	7 756 332,78
Gross livestock production, million tenge	3 860 852,98	4 219 403,87	4 577 954,77
Services in the field of agriculture, million tenge	12 662,47	12 787,62	12 912,77
Level of profitability (unprofitability) of agricultural production in agricultural enterprises of the RK, in %	46,88	50,01	53,12
Level of profitability (unprofitability) of livestock production in agricultural enterprises of the RK, in %	18,22	17,75	17,28
Specified sown area of agricultural crops for all categories of farms, thousand hectares	23 869,01	24 343,42	24 817,80
Rural housing stock, total area of housing, at the end of the year, million sq. m. m	143 222,4	145 870,8	148 519,2
Note: compiled by the authors based on calculations			

The above forecasting method can be used as the basis for forecast calculations (Doholjan, S.V.) [13] Based on the above computational algorithm, regression equations and their statistical characteristics are determined that describe the reliability of calculated parameter.

Discussions

Within the framework of the presented economic and mathematical method, the

analysis of the current state of the main factors of agricultural production, based on the use of statistical indicators of dynamic time series., it was found that the created models on which the forecast is based, using probability levels R2, suggest that while maintaining the established patterns of development, the predicted value will correspond to the calculated values of the identified trend changes in indicators (Yesbergen R.A., Yessengaziyeva S.K., Asrepov G.N.) [14].

As the analysis of the created models showed, with the preserved patterns observed during the analyzed period, according to the calculated data, the GDP growth trend will continue, both in crop production and in animal husbandry. There will be annual growth, on average by 8-9% in animal husbandry, and by 11-12% in crop production, in the absence of force majeure. There will be growth in the service sector, and as a result, the level of profitability of agricultural production will increase. However, these funds are still insufficient, it is necessary to increase investments in research and development, in the introduction of new technologies, the development of innovative infrastructure, intensive management methods, especially in the field of animal husbandry, where, given the prevailing trends, the dynamics of declining profitability of production will continue (table 4).

One of the important factors in the growth of innovation activity and investment in the agricultural sector is the joint cooperation of the state with representatives of agribusiness aimed at the development of innovative infrastructure.

Based on the conducted research, we came to the conclusion that further successful development of agriculture is possible in conditions of significant investments in environmental protection, in scientific research of innovative products, which will contribute to the production of environmentally friendly products and GDP growth in agriculture (Abraliyev O., Sugirova G., Velesco S.) [15].

Conclusion

Thus, in order to ensure innovative growth in the agro-industrial complex, it is necessary to develop innovative infrastructure based on joint cooperation between the state and agribusiness, including the following activities:

- allocation of funds and investments for the formation of a scientific, technical and innovative strategy for the development of agriculture;

- formation of a consulting and information type of management in public local institutions, based on the timely provision of consulting, engineering and marketing services to agricultural producers, which will reduce innovation and investment risks;

- improvement of the regulatory and legislative framework in the field of agriculture, to improve the system of insurance and guarantee of investments against environmental risks;

- active participation of unions and associations of agricultural producers in activities aimed at realizing the goals of innovative agricultural policy;

- formation and training of personnel in the field of innovation management in the agro-industrial complex, to develop measures to stimulate and attract young and creative specialists to the agricultural sector.

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