

RESEARCH ARTICLE

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The Analysis of the Relationship Between Innovation and the Development of the Agro-Industrial Complex in Kazakhstan

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Abstract

This study investigates the relationship between innovation and the agro-industrial complex's (AIC) development in Kazakhstan. In the context of global shifts in technology, labor, and capital markets, the research examines the role of innovation in enhancing the AIC's competitiveness. The primary focus is on the dynamics of innovation in agriculture, particularly how it influences factors like human capital, innovation activity levels, and the role of science and scientists. The research employs a two-stage methodology involving descriptive analysis and hypothesis testing, using SMART-PLS software for data-driven analysis. Key indicators considered include employment in agriculture, innovation activity, and agricultural credit loans. The period from 2013 to 2019 is analyzed, testing hypotheses about the impact of agricultural credit loans on innovation, the influence of innovation on agriculture's share in GDP, and its effect on the number of farms. The results highlight the significant role of innovation and financial support in advancing Kazakhstan's agricultural sector. Agriculture Credit Loans and the increase in the Number of Farms substantially boost innovation in the AIC contributing to its growth and greater GDP share. While the Share of Agriculture in GDP also positively impacts innovation, its effect is less pronounced. The research underscores the necessity of collaboration between agricultural enterprises and research institutions and the vital role of financial support in driving sustainable growth and development.

Keywords: Economy, Agro-Industrial Complex, Innovations, Innovative Development, Innovation Activity, Sustainable Development, Kazakhstan

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JEL Code: Q16, Q18, L52

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1. INTRODUCTION

The modern era is characterized by rapid and profound changes in sectors of the economy, including environmental aspects, science, technology, and socio-cultural aspects of society. Innovation is decisive in ensuring competitive advantage, sustainability, and the need to rise to challenges. By supporting the processes of change and progress, innovation becomes the driving force of economic progress and the main driving force shaping this modern face of society.

With the development of new economic and sustainable paradigms such as the bioeconomy, circular economy, resource efficiency and biorefinery, the understanding that as these concepts are applied to the lean economy, research into the relationship between innovation and productivity in agriculture has become increasingly important (Viaggi, 2015).

Among the various sectors of the economy, the agro-industrial complex (AIC) is one of the most important, as it is directly related to ensuring food security, considering consumer demands and severe environmental and socio-economic problems. The effective functioning and development of the agricultural sector require innovative approaches and solutions that can increase productivity and improve product quality.

Innovation plays an important and decisive role in the modern development of the agro-industrial complex. It is considered a key mechanism for increasing competitiveness, business efficiency and the sustainability of economic activity in this industry. Global trends, such as changes in the labor market and availability of capital and technology, impact the agricultural sector and create new opportunities and challenges for enterprises (Chikov, 2020; Nurmanbetova et al., 2021).

Introducing new technologies plays a crucial role in expanding agricultural production in Kazakhstan. The availability and application of scientific developments in rural areas and the effectiveness of advisory services are possible factors for solving problems at present (Souca et al., 2021)

Continuous innovation is a system of consistent activities for implementing scientific developments. Agricultural production, characterized by high complexity, requires a particular approach to organizing the innovative activities of business entities.

In developed countries, specialized centres of knowledge and ideas are being formed in the agricultural sector, which allows agriculture to move to a higher level of technology based on experience, knowledge and scientific achievements.

Agriculture in the Republic of Kazakhstan has significant potential and extensive opportunities. The diverse climatic conditions in the country allow the cultivation of almost all crops in the temperate thermal zone and the development of livestock farming. The government of Kazakhstan is actively focusing on attracting the latest technologies and promoting innovation in agriculture. In 2020, Kazakhstan received a \$500 million loan from the World Bank to implement the Sustainable Livestock Development Program. The goal of the program is to support the sustainable development of livestock farming through the development of infrastructure for open-grazing livestock and the creation of a monitoring system for beef production following international standards (Timakova, 2020).

However, despite all the efforts, the main problem in Kazakhstan is creating conditions for its sustainable growth and increasing the competitiveness of products for developing the agricultural sector. The solution to this problem includes ensuring the stable development of agriculture and improving the quality of its products through stimulating innovative activity based on the development and use of advanced types of innovation, reflecting the latest scientific and technical achievements.

The primary goal of this research is to investigate the multifaceted relationship between innovation and the development of the agro-industrial complex in Kazakhstan. The study analyses this relationship by examining key indicators encompassing various domains. Particular attention

will be paid to factors such as human capital, the level of innovation activity, and the role of science and scientists in this context. As part of the study, current trends, challenges and opportunities associated with the difficulties of modern agricultural systems will be examined, and practical recommendations for enhancing innovation in the agro-industrial complex will be offered.

2. LITERATURE REVIEW

In the modern world, economic policy is an important indicator of the national economy and ensures food security for millions of people. One of the most important aspects of agriculture is innovation. Financial support and demographic changes, such as an ageing population and changing labor force structure, play a crucial role in developing an innovative economy in the economic sector. Wheeler (2008) discusses organic farming as a potential innovation in agriculture and examines factors influencing agricultural professionals' attitudes toward this innovation. The role of the scientific community is emphasized in the context of promoting innovation in agriculture, where the scientific community evaluates technologies and practices such as organic farming, conducting research and providing scientific justification.

Financial support and lending for agricultural enterprises is highlighted as a key factor for increasing production efficiency and meeting the food needs of the population. This contributes to the formation of a competitive innovative economy, including the rural sector, which is important for ensuring sustainable development, increasing labor productivity in agriculture and improving product quality (Chen & Yada, 2011; Dorzhieva & Dugina, 2015). One of the main conditions for development is the use of advanced scientific and technological achievements, new highly efficient methods of rural production, as well as the modernization of agricultural enterprises (Mexmonov, 2019). Sokolova and Litvinenko (2020) highlighted innovation's social and economic benefits for society and the state. Innovation helps improve living standards and the quality of products, create new jobs and reduce social inequality, especially in rural areas. The authors note that the need for more qualified personnel is one of the barriers to innovation in agribusiness. Moreover, the introduction of new technologies requires specific knowledge and skills. Technology plays a decisive role in innovative development. The introduction of automation, artificial intelligence and robotics can significantly increase labor productivity and competitiveness of agricultural enterprises (Faskhutdinova et al., 2020; Hrustek, 2020).

Innovation and willingness to adopt new technologies play an important role in the growth of agribusiness. However, developing countries have low investment in research and development (R&D), which limits access to new technologies and innovations (Lybbert & Sumner, 2012). Adenle et al. (2017) discuss the role of innovation in agriculture and its impact on sustainable development and the conditions under which official development assistance can be more effective in promoting sustainable development in agriculture in sub-Saharan Africa. Also, factors influencing the introduction of new technologies in agriculture are highlighted, including social, cultural, economic and technological characteristics, as well as the role of market regulators and social norms and values in adopting new technologies. It is highlighted that African agriculture is undergoing a technological revolution, and there is growing support for advanced technologies due to the unsustainability of traditional farming methods. However, adopting advanced technologies is only a partial solution for agriculture in Africa. It mentions factors such as farm size, technology adoption costs and the influence of neighboring farmers playing an essential role in adopting new agricultural technologies. Adopting new technologies also depends on factors such as labor intensity, land-saving technologies and farmer innovation. Additionally, access to finance plays an important role in the development of agribusiness in Africa. However, the lack of reliable financial institutions and weak links with global financial systems and capital markets are major barriers to agribusiness investors. High inflation and macroeconomic instability may

also increase operating costs and create uncertainty for investors (Adenle et al., 2019; Pathak et al., 2019). Implementing innovation still requires significant financial resources, and this limits the ability of small and medium-sized agricultural enterprises to finance innovative projects, which could lead to sector consolidation.

Particular attention is paid to demographic changes, such as the ageing population and the changing structure of the labor force. These changes bring significant transformations to the labor market, which poses severe challenges for agricultural enterprises, especially in the context of urbanization and a declining rural population. Anastasiou et al. (2021) state that demographic changes in rural Greece significantly impact innovation in the country's agribusiness sector. The Greek countryside is characterized by increasing demographic vulnerability linked to broader social and economic issues. This vulnerability is exacerbated by the diversity and unevenness of the population in Greece, which contributes to inequality and impacts social and economic development in local rural areas. The influence of demography on innovation in the agricultural sector can be seen in the fact that the increasing ageing of the population and the outflow of young rural workers are reducing the share of the active working population available for agriculture and innovation in this area (Jansuwan & Zander, 2021; Ngadi et al., 2023). An ageing population also means that rural areas may need more competent workers with young, innovative ideas. Demographic changes such as ageing populations and declining birth rates, which simultaneously lead to population decline have significant impacts on sustainability and have important implications for achieving the Sustainable Development Goals. However, this issue has received limited political and practical attention (Jarzebski et al., 2021)

There is a need to improve financial services and economic infrastructure and invest in research and innovation to promote agribusiness development and thus contribute to the region's economic growth and poverty alleviation. Access to credit in the rural sector is critical in accelerating the adoption of agricultural technologies and increasing productivity. By providing access to credit, farmers can afford to adopt technologies. This, in turn, can lead to increased yields, improved quality of agricultural products and increased income for farmers (Wangwe & Lwakatare, 2004). The number of farms, their agricultural systems and their characteristics play an important role in understanding innovation activity in agriculture, providing context and factors influencing the adoption of innovations. Additionally, farm size, access to credit, and other farmer characteristics in their decision to innovate play a crucial role (Läpple et al. (2015). Moreover, the development of rural finance related to financial support of agricultural business can significantly contribute to innovation in agriculture and that the effectiveness of rural finance has a more significant impact in regions with low market orientation (Liu et al., 2021).

Conducted review of existing studies of innovation development in agriculture highlighted the importance of access to finance and number of business entities in agriculture as key indicators for innovation development in agriculture. Studies provided qualitative research as questionnaires and majority used secondary data. Nevertheless, it must be considered that the period of observation covered in the literature was about ten years or more. there is still lack of complex studies.

Current scientific article highlights the importance of innovation for the agricultural sector and several key factors that determine successful innovative development in this industry, such as access to qualified personnel, financing, technology, and social benefits for society and the state. This analysis is essential for understanding and facilitating innovation processes in the agribusiness sector.

3. METHODOLOGY

The research methodology for current study was developed based on the provided literature review. Much of the existing studies in the attempt to analyze the relationship between

innovation and agriculture development rely on human capital. Therefore, it is often that studies used demographic indicators. At the same time studies show that financial support for agribusiness development is crucial in developing countries. Therefore, the research methodology consists of two main stages, which are illustrated in Figure 1.

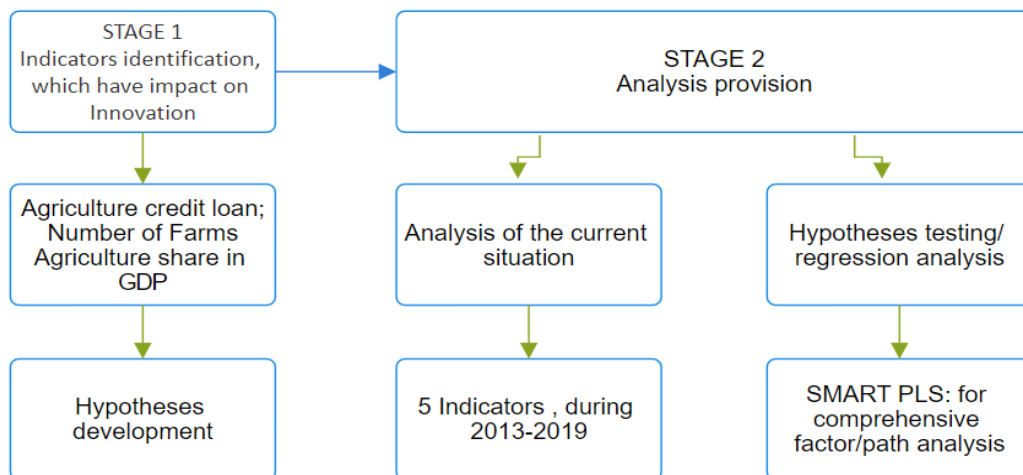


FIGURE 1. Research stages

Note: compiled by authors

STAGE 1. Based on the literature review, key groups of indicators were identified for descriptive analysis and hypothesis testing. Thus, for the analyses of current situation, there were selected five indicators:

- (1) Number of people employed in agriculture, forestry and fisheries.
- (2) Number of employees engaged in research and development activities.
- (3) The level of innovation activity and the share of innovative products in GDP.
- (4) The number of enterprises in the agro-industrial complex and their share in GDP.
- (5) Issuance of loans to agriculture through the Agrarian Credit Corporation (in billions of KZT)

Based on the data-driven analysis and in-depth literature review, three fundamental hypotheses were formulated to assess specific relationships within the context of the agro-industrial complex in Kazakhstan:

Hypothesis 1: Agriculture Credit Loan has a significant positive impact on innovation development.

Hypothesis 2: Innovation has a significant positive impact on the share of agriculture in GDP.

Hypothesis 3: Innovation has a significant positive effect on the number of farms.

In order to analyzing the relationship between innovation and the development of the agro-industrial complex in Kazakhstan there identified main indicators:

Innovation activity is a measure of the degree of involvement and activity of organizations or industries in the processes of introducing and developing innovations. This indicator assesses the readiness and ability of economic entities to introduce new ideas, technologies or methods in their activities. Innovation activity may include aspects such as the amount of investment in research

and development, the number of patented technologies, the level of collaboration with academic and research institutions, and the success of implementing innovations in practice. This indicator is an important component of assessing the innovative potential and competitiveness of economic entities.

The dynamics on the credit loan for development of agriculture. Financial support and lending. Much attention is paid to the role of financial support and lending to agricultural enterprises in achieving sustainable development of the agro-industrial sector.

The share of the agro-industrial complex (AIC) in the gross domestic product (GDP) is the percentage of the gross value added of agriculture and related industries to the total gross economic output of the country. This indicator reflects the contribution of agriculture to the overall economy and can serve as an indicator of the economic influence of the agricultural sector. The high share of the agro-industrial complex in GDP may indicate the significant contribution of agriculture to the economic development of the country.

The indicator "*Number of Farms*" refers to the number of agricultural enterprises that operate in a certain territory or country. This indicator may include all types of agricultural enterprises, including farms, large agricultural firms and cooperatives. A large number of agro-industrial complexes may indicate a significant contribution of the agricultural sector to the overall structure of production and employment in a given territory.

Software justification. SMART-PLS software was used for the analysis provision.

PLS-SEM stands for "Partial Least Squares Structural Equation Modeling." It is a methodology used in research to analyze complex relationships between variables in models, especially in cases where data may be multimodal or does not adhere to a normal distribution.

Partial Least Squares (PLS) is a regression analysis method used to estimate parameters in models with numerous variables and intricate structures. PLS works by minimizing the sum of squared residuals, allowing for efficient modeling of multiple variables. Structural Equation Modeling (SEM) is a method for estimating and testing structural relationships between latent (unobservable) variables based on their observed indicators. SEM involves parameter estimation and hypothesis testing of structural relationships. PLS-SEM is flexible and applicable in cases of small samples. This makes it preferable for current research as the main limitation to this research was lack of data. Therefore the observing period includes from 2013 to 2019 (Atker et al., 2017).

Model. Next, an analytical model approach was developed to assess the impact of innovation on agricultural development in Kazakhstan. Coefficients of determination (R-squared) were calculated for each dependent variable to assess how well the model fit the data. An analysis was also conducted to assess the reliability of the innovation measures. A path analysis was conducted to assess the impact of innovation on agriculture and the impact of agricultural lending on innovation development.

4. FINDINGS AND DISCUSSION

The initial phase of this study involves a meticulous examination of pertinent indicators to illuminate the intricate relationship between innovation and the burgeoning agro-industrial complex within the context of Kazakhstan. Figure 2 provides data on the employed population in agriculture, forestry and fisheries and the number of workers carrying out research and development work from 2013 to 2019.

According to the data, there has been some growth in the employed population in the agriculture, forestry and fisheries group from 2013 to 2016, with a peak in 2016 (1,360 people). After 2016, a decline began, and by 2019, the employed population had decreased again but remained above the original level (831 people in 2013). The overall trend in this category shows instability and fluctuations in employment in agriculture, forestry and fisheries over the period.

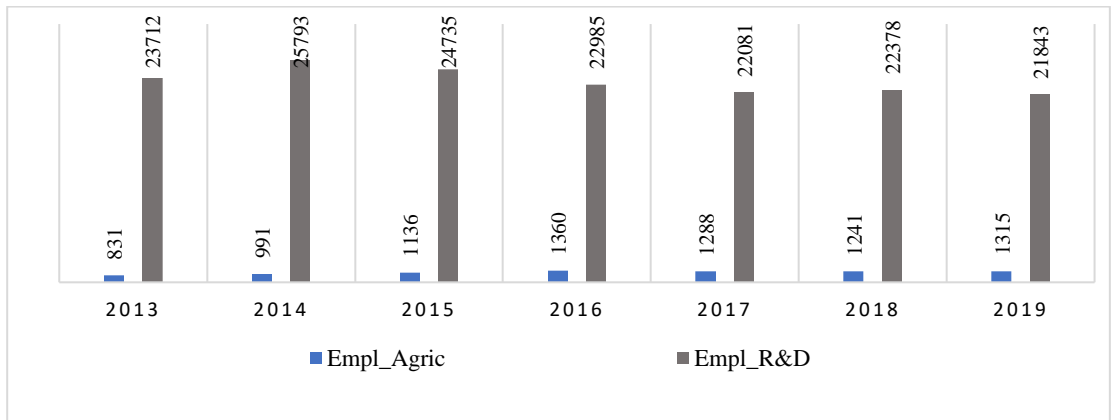


FIGURE 2. Number of employed people in agriculture, forestry and fisheries and the number of workers carrying out research and development work for 2013-2019

Note: compiled by authors based on Bureau of National Statistics (2022)

The number of employees in research and development also shows some fluctuations during the period, but they are less pronounced than in the previous category. The maximum number of employees (25,793 people) was registered in 2014, and the minimum value (21,843 people) was registered in 2019. The general trend indicates a moderate decline in the number of workers in this category, but it remains relatively stable.

The level of activity in the field of innovation ranges from 8 to 11 during the study period. Notably, the activity level began to increase in 2016, peaking in 2018 and 2019. This may indicate a more active innovation development in this area in these years. Moreover, the share of innovative products in GDP ranges from 0.92% to 1.72% during the analyzed period. In 2015, there was a sharp decline in the share of innovative products, but after that, it began to grow, reaching a peak in 2018. In 2018, the highest share of innovative products in GDP was recorded (1.72%), which may indicate an increase in the contribution of innovation to the regional economy (see Figure 3).

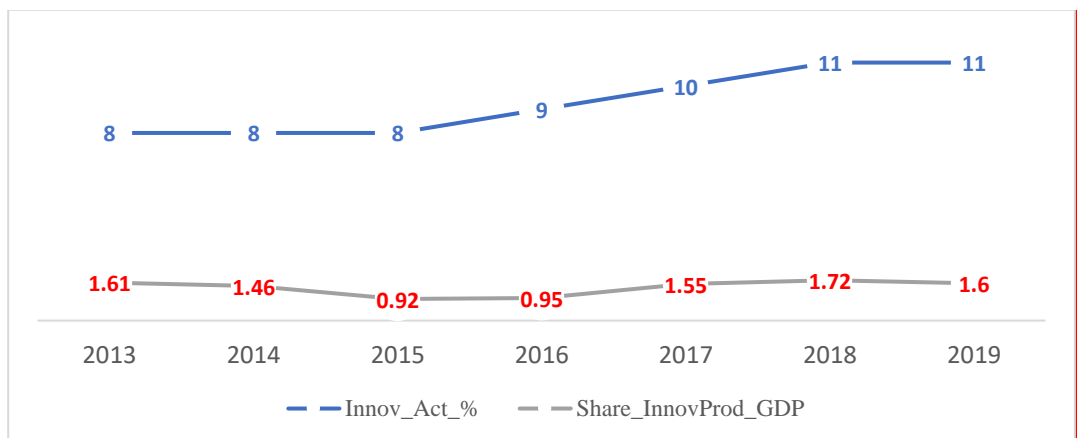


FIGURE 3. Level of activity in the field of innovation and the share of innovative products in GDP

Note: compiled by authors based on Bureau of National Statistics (2022)

The data shows that the employed population in agriculture, forestry and fisheries is subject to significant fluctuations. At the same time, the number of workers engaged in research and development activities is less subject to fluctuations and remains at a more stable level. Understanding these trends can help develop appropriate development strategies for the region.

Based on the data provided, we can conclude that the level of activity in the field of innovation began to grow in the second half of the analyzed period (since 2016), and the share of innovative products in GDP also showed an increase, especially in 2018. These data may indicate more active innovative development of the region and its contribution to the economy.

The number of agro-industrial complexes and the share of agro-industrial complexes in GDP gradually increased from 2013 to 2019, which may indicate the growth of the agro-industrial sector in the country. During the analyzed period, agro-industrial complexes increased by approximately 107,706 enterprises. The share of the agro-industrial complex in GDP also fluctuates during the period, but the general trend indicates an increase in this share. It is important to note that in 2013, the share of the agricultural sector was 17% of GDP, and by 2019 it increased to 32%. This growth indicates a more active participation of agriculture in the economy of Kazakhstan (see Figure 4).

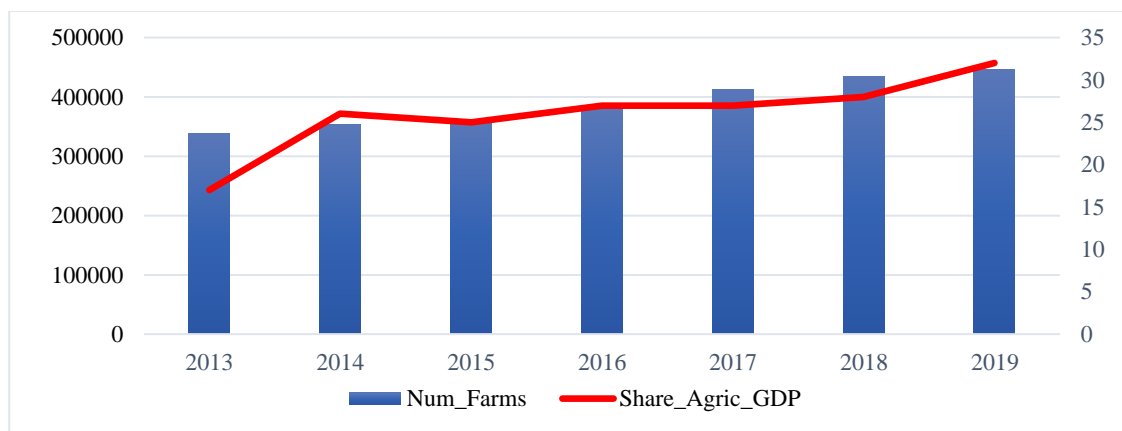


FIGURE 4. Number of agro-industrial complex and share of agro-industrial complex in GDP for 2013-2019

Note: compiled by authors based on Bureau of National Statistics (2022)

Based on the data provided, we can conclude that agriculture in the country is showing growth, which indicates the significant role of agriculture in the country's economy and its increased contribution to GDP. Agricultural lending in Kazakhstan remains low, and the state is crucial in providing financial support to agricultural producers. The most important institution providing preferential loans to agriculture in the country is JSC Agrarian Credit Corporation (ACC). The corporation played a significant role in lending to the country's agricultural sector, providing more than half of all loans (52.6%) in the amount of 488.1 billion tenge by the end of June 2020.

During the analyzed period, there was a stable increase in the volume of lending to the agricultural sector. The lending volume increased from 38.118 billion tenge in 2013 to 157.847 billion tenge in 2019. This trend indicates a gradual increase in financial support for agriculture during the analyzed period (see Figure 5).

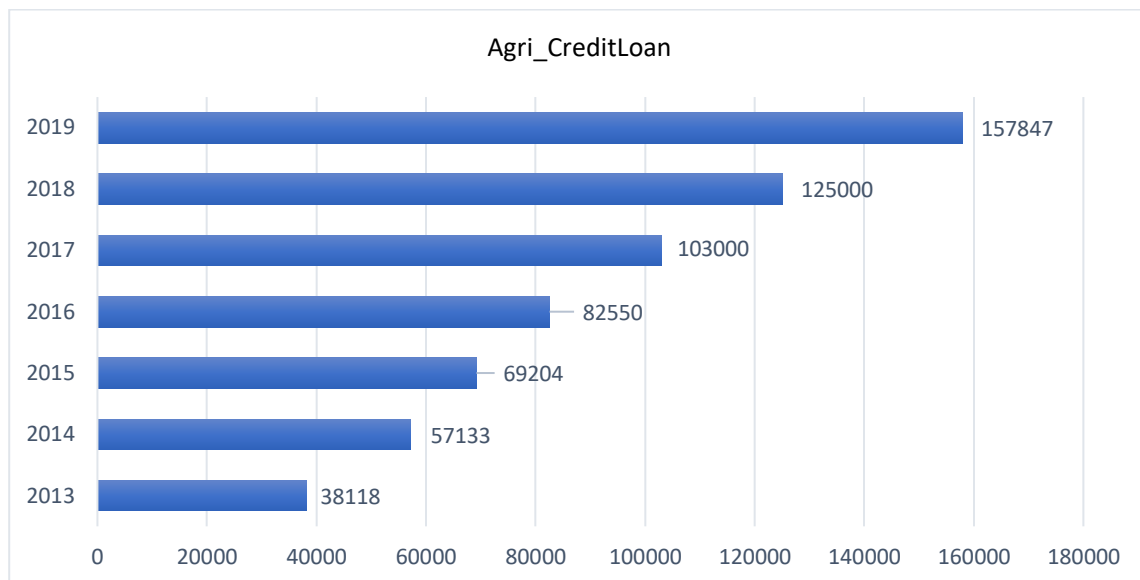


FIGURE 5. Lending to agriculture through Agrarian Credit Corporation JSC, billion KZT

Note: compiled by authors based on Bureau of National Statistics (2022)

In order to understand the dynamics, we can calculate the growth rate of lending to the agricultural sector. Therefore, it is necessary to calculate the relative change in lending volume relative to the previous year:

- 2014: $(57133 - 38118) / 38118 \approx 0.498$ (or 49.8%)
- 2015: $(69204 - 57133) / 57133 \approx 0.211$ (or 21.1%)
- 2016: $(82550 - 69204) / 69204 \approx 0.192$ (or 19.2%)
- 2017: $(103000 - 82550) / 82550 \approx 0.245$ (or 24.5%)
- 2018: $(125000 - 103000) / 103000 \approx 0.213$ (or 21.3%)
- 2019: $(157847 - 125000) / 125000 \approx 0.262$ (or 26.2%)

Growth rates vary but remain positive on average, indicating a steady increase in lending volumes. The overall dynamics show that the agricultural sector in the country is receiving more and more loans, which can contribute to its growth and development. This is a positive sign for the agricultural industry as financial support can help improve productivity and ensure sustainable development. Next, there was conducted analysis of the impact of Innovation on agriculture development in Kazakhstan. The model is provided in Figure 6.

High R-squared values indicate a good fit of the model to the data. The results show that the model explains the variation in the variables well: Innovation: 83.9%, Number of Farms: 90.6% and Share of Agriculture to GDP: 43.5%. To assess the reliability of innovation measurements, the following analyzes were conducted (see Table 1).

TABLE 1. Construct reliability and validity results

Variable	Cronbach's alpha	Composite reliability (rho_a)	Composite reliability (rho_c)	Average variance expected (AVE)
Innovation	0.956	0.971	0.978	0.958

Note: compiled by authors

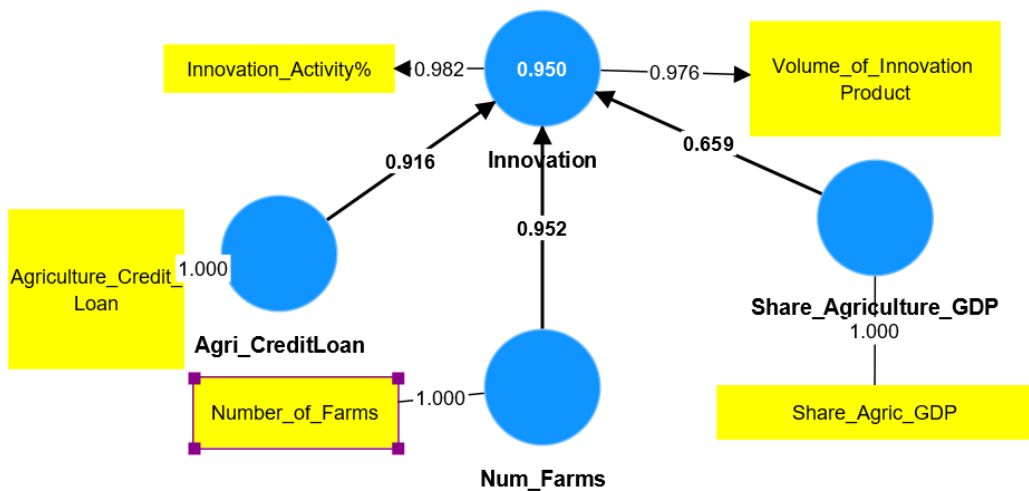


FIGURE 6. Model results

Note: compiled by authors

Cronbach's alpha: 0.971 is a high value, indicating high internal reliability of the measurements. Composite reliability (rho_a): 0.978 is also a high value indicating the reliability of the measurements. Average Variance Extracted: 0.958 is also a high value, indicating good convergent validity.

Path coefficients analysis was conducted to estimate the effect of one innovation on agriculture and the effect of credit loan to agriculture businesses on innovation development. The results show the following significant paths in Table 2.

TABLE 2. Path coefficients

Indicator	Original Sample (O)	Sample mean (M)	Standard deviation (STDEV)	T statistics (O/STDEV)	P values
Agriculture Credit Loan -> Innovation	0.916	0.918	0.134	6.833	0.000
Innovation -> Number of Farms	0.952	0.950	0.129	7.379	0.000
Innovation -> Share of Agriculture to GDP	0.659	0.721	0.178	3.709	0.000

Note: compiled by authors

Agriculture Credit Loan -> Innovation: Coefficient of 6.833 with T-statistic and p-value of 0.000, indicating a statistically significant positive effect of Agriculture Credit Loan on Innovation. *Innovation -> Number of Farms*: Coefficient of 7.379 with T-statistic and p-value of 0.000, indicating a statistically significant positive effect of Innovation on Number of Farms. *Innovation -> Share of Agriculture to GDP*: Coefficient of 3.709 with T-statistic and p-value of

0.000, indicating a statistically significant positive effect of Innovation on Share of Agriculture to GDP.

So, based on the results provided, the models have good explanatory power and confirm the statistically significant impact of Agriculture Credit Loan on Innovation, Innovation on Number of Farms and Innovation on Share of Agriculture to GDP.

The power of the Innovation variable on Number of Farms (Coefficient = 7.379) is significantly higher than the power of Innovation on Share of Agriculture to GDP (Coefficient = 3.709). This means that each change in innovation activity has a stronger impact on the number of farms than on the share of agriculture in GDP.

Both coefficients are statistically significant at the 0.05 significance level (p-value is 0.000 for both). This means that there is a statistically significant positive effect of Innovation on both dependent variables.

The T-statistic for Innovation -> Number of Farms (7.379) is higher than for Innovation -> Share of Agriculture to GDP (3.709). This also indicates a stronger statistical effect of Innovation on the number of farms. Overall, the results show that innovation activity has a stronger and statistically significant positive effect on the Number of Farms than on the Share of Agriculture to GDP.

The summary of the results of the research analysis are performed in Table 3.

TABLE 3. Research results

No.	Hypotheses	P value	R squared	Result
H 1	Agriculture Credit Loan has a significant positive impact on innovation development.	0.000	83.9%	Supported
H 2	The share of agriculture in GDP. has an insignificant positive impact on innovation development	0.000	43.5%.	Supported: partially
H 3	The number of farms has a significant positive impact on innovation development	0.000	90.6%	Supported
<i>Note:</i> compiled by authors				

The results of the research showed that all predictors (the number of farms, the share of agriculture to GDP and agriculture credit loan) have impact on the innovation development. However, depending on the R-squared the level of the impact of each predictor is different. Thus, the number of farms and agriculture credit loan have significant positive impact on the innovation development – Hypotheses 1 and 3 are supported. In contrast, the R-squared for the share of agriculture in GDP is lower, which allows to conclude that it has insignificant impact on the innovation development and only explains 43.5%. of the change in the dependent variable. Therefore, Hypothesis 2 is supported partially, as its impact is insignificant.

5. CONCLUSIONS

In conclusion, this study embarked on a comprehensive exploration of the intricate relationship between innovation and the development of Kazakhstan's agro-industrial complex. There were developed three hypotheses of which two were supported and one partially supported.

In alignment with the hypotheses, the path analysis unveiled significant positive effects. Agriculture Credit Loan demonstrated a substantial positive impact on innovation development, affirming the importance of financial support (Hypothesis 1). Share of Agriculture in GDP exerted an insignificant positive influence on Innovation (Hypothesis 3) and there was a significant positive influence of the Number of Farms on Innovation (Hypothesis 2), reinforcing its role in driving growth within the agro-industrial complex.

The results revealed noteworthy trends and patterns within the agro-industrial sector. Notably, the employed population in agriculture, forestry, and fisheries exhibited fluctuations, while the number of workers engaged in research and development activities remained relatively stable. These findings underscore the importance of understanding the dynamics of employment within the sector, which can inform strategic development initiatives.

Moreover, the level of innovation activity experienced an upswing from 2016 onwards, indicating a growing impetus for innovation within the region. The concurrent rise in the share of innovative products in GDP, particularly in 2018, further underscores the increasing contribution of innovation to the regional economy. These trends signify a positive trajectory in terms of innovative development.

The growth in the number of agro-industrial complexes and their rising share in GDP underscore the burgeoning significance of the agricultural sector in Kazakhstan's economy. This expansion suggests that agriculture is assuming a more substantial role in the nation's economic landscape.

The analysis of lending to the agricultural sector revealed a consistent increase in lending volumes during the period under examination. This positive growth trend is indicative of increased financial support for agriculture, which is crucial for enhancing productivity and ensuring sustainable development within the sector. According to the results obtained, there were developed following recommendations.

Given the statistically significant positive effect of Agriculture Credit Loan on Innovation, policymakers could focus on initiatives that enhance access to credit for agriculture businesses. This might involve creating favorable credit policies, reducing interest rates, or establishing credit facilities tailored to the needs of the agricultural sector. Recognizing the strong positive impact of innovation on both the Number of Farms and the Share of Agriculture to GDP, stakeholders could develop and support innovation programs in the agricultural sector. This might include funding research and development, providing incentives for adopting new technologies, and fostering collaboration between research institutions and farmers.

Since the research emphasizes the significance of innovation in driving agricultural outcomes, policymakers could invest in capacity-building programs. This could involve training farmers and agricultural businesses in modern farming techniques, technology adoption, and sustainable agricultural practices. Given the potential variability in the impact of predictors, stakeholders in Kazakhstan could benefit from collaborating with international organizations and other countries facing similar challenges. Sharing best practices, lessons learned, and successful policy interventions can contribute to more effective and tailored strategies for the agricultural sector.

In summation, this research underscores the pivotal role played by innovation in fostering the development of Kazakhstan's agro-industrial complex. It highlights the importance of financial support mechanisms and the adoption of advanced technologies in propelling sustainable growth within the sector. This study contributes to the body of knowledge surrounding innovation and agricultural development, providing valuable insights for policymakers, researchers, and stakeholders invested in the progress of the agro-industrial complex in Kazakhstan.

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