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INNOVATIVE EDUCATION ECOSYSTEM AS A FACTOR IN MANAGING THE LABOUR POTENTIAL OF RURAL AREAS

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Abstract. In the context of Kazakhstan's economic modernisation, the formation of an innovative education ecosystem as a key tool for managing the labour potential of rural areas is becoming particularly important. The problem under investigation is the continuing shortage of skilled personnel in rural areas, especially in the agricultural, engineering, technical and medical fields, which limits the potential for sustainable socio-economic development in these regions.

The aim of this work is to determine the role of an innovative educational environment in the development and effective use of the labour potential of rural areas in Kazakhstan. The study uses statistical and comparative analysis methods, as well as systemic and structural-functional approaches. The empirical basis consists of data on employment by age and education, the number of technical and vocational education (TVE) institutions, the number of students and higher education institutions, which made it possible to identify trends and imbalances in the formation of human resources.

The results of the study showed that the number of students in the vocational education system is growing, but the proportion of rural youth receiving vocational education is declining. The age structure of the labour force is characterised by ageing, and the proportion of specialists with higher education remains low. These factors point to the need to update educational programmes, develop dual training and expand employer participation in staff training.

The practical significance of the study lies in the formulation of proposals to strengthen the innovative ecosystem of education, including the integration of science, business and local authorities. The implementation of such measures will improve the quality of human capital, reduce youth migration from rural areas and ensure the sustainable development of rural regions of Kazakhstan based on innovation and digitalisation of the agricultural sector.

Keywords: educational innovation ecosystem, labor potential management, rural areas, migration, personnel shortage.

БІЛІМ БЕРУДІҢ ИННОВАЦИЯЛЫҚ ЭКОЖҮЙЕСІ АУЫЛДЫҚ АУМАҚТАРДЫҢ ЕҢБЕК ӘЛЕУЕТІН БАСҚАРУ ФАКТОРЫ РЕТІНДЕ

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Аңдатпа. Қазақстан экономикасын жаңғырту жағдайында ауылдық аумақтардың еңбек әлеуетін басқарудың негізгі құралы ретінде білім берудің инновациялық экожүйесін қалыптастыру ерекше маңызға ие болып отыр. Зерттеу мәселесі ауылдық жерлерде, әсіресе аграрлық, инженерлік-техникалық және медициналық салаларда білікті кадрлардың тапшылығының сақталуында, бұл өз кезегінде өңірлердің тұрақты әлеуметтік-экономикалық дамуына кедергі келтіруінде.

Зерттеу жұмысының мақсаты — Қазақстанның ауылдық аумақтарындағы еңбек әлеуетін дамыту мен тиімді пайдалану процесінде инновациялық білім беру ортасының рөлін айқындау. Зерттеу барысында статистикалық және салыстырмалы талдау әдістері, сондай-ақ жүйелік және құрылымдық-функционалдық тәсілдер қолданылды. Эмпириқалық негіз ретінде халықтың жасы мен білімі бойынша жұмыспен қамтылу деректері, техникалық және кәсіптік білім беру (ТжКБ) ұйымдарының саны, студенттер мен жоғары оқу орындарының көрсеткіштері пайдаланылып, кадрлық әлеуетті қалыптастырудағы үрдістер мен теңсіздіктер анықталды.

Зерттеу нәтижелері ТжКБ жүйесіндегі студенттер санының өскенін, алайда кәсіби білім алып жатқан ауыл жастарының үлесі азайғанын көрсетті. Еңбек ресурстарының жас құрылымы қартаю үрдісімен сипатталады, ал жоғары білімді мамандардың үлесі төмен деңгейде қалып отыр. Бұл факторлар білім беру бағдарламаларын жаңартудың, дуальды оқытуды дамытудың және жұмыс берушілердің кадр даярлауға қатысуын кеңейтудің қажеттілігін көрсетеді.

Зерттеудің практикалық маңызы — ғылым, бизнес және жергілікті билік органдарының интеграциясын қамтитын білім берудің инновациялық экожүйесін нығайту бойынша ұсыныстар әзірлеуде. Мұндай шараларды іске асыру адами капитал сапасын арттыруға, ауыл жастарының көші-қонын азайтуға және Қазақстанның ауылдық өңірлерін аграрлық сектордың инновацияландыруы мен цифрландырылуы негізінде тұрақты дамытуға мүмкіндік береді.

Түйін сөздер: білім берудің инновациялық экожүйесі, еңбек әлеуетін басқару, ауылдық аумақтар, көші-қон, кадр тапшылығы.

ИННОВАЦИОННАЯ ЭКОСИСТЕМА ОБРАЗОВАНИЯ КАК ФАКТОР УПРАВЛЕНИЯ ТРУДОВЫМ ПОТЕНЦИАЛОМ СЕЛЬСКИХ ТЕРРИТОРИЙ

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Аннотация. В условиях модернизации экономики Казахстана особую значимость приобретает формирование инновационной экосистемы образования как ключевого

инструмента управления трудовым потенциалом сельских территорий. Проблема исследования заключается в сохраняющемся дефиците квалифицированных кадров на селе, особенно в аграрной, инженерно-технической и медицинской сферах, что ограничивает возможности устойчивого социально-экономического развития регионов.

Целью работы является определение роли инновационной образовательной среды в развитии и эффективном использовании трудового потенциала сельских территорий Казахстана. В исследовании использованы методы статистического и сравнительного анализа, а также системный и структурно-функциональный подходы. Эмпирическую базу составили данные по занятости населения по возрасту и образованию, количеству организаций технического и профессионального образования (ТиПО), численности студентов и вузов, что позволило выявить тенденции и диспропорции в формировании кадрового потенциала.

Результаты исследования показали, что численность студентов в системе ТиПО растёт, однако снижается доля сельской молодёжи, получающей профессиональное образование. Возрастная структура трудовых ресурсов характеризуется старением, а доля специалистов с высшим образованием остаётся низкой. Эти факторы указывают на необходимость обновления образовательных программ, развития дуального обучения и расширения участия работодателей в подготовке кадров.

Практическая значимость исследования состоит в формировании предложений по укреплению инновационной экосистемы образования, включающей интеграцию науки, бизнеса и местных органов власти. Реализация таких мер позволит повысить качество человеческого капитала, сократить миграцию молодёжи из села и обеспечить устойчивое развитие сельских регионов Казахстана на основе инноваций и цифровизации аграрного сектора.

Ключевые слова: инновационная экосистема образования, управление трудовым потенциалом, сельские территории, миграция, кадровый дефицит.

Introduction. The development of rural areas is a strategic direction for Kazakhstan's sustainable socio-economic growth. In the context of the transition to a knowledge-based economy and the digital transformation of society, not only the introduction of innovations but also the effective management of educational processes that ensure the training of a new generation of personnel is of key importance. For a country where a significant part of the population lives in rural areas, the creation of an innovative education ecosystem capable of supporting human capital development and improving the quality of labour resources is a priority.

The modern challenges facing rural areas include a decline in the labour force caused by the migration of young people to cities, a shortage of skilled workers, poor development of educational infrastructure and limited access to modern technologies. In these conditions, education becomes a key tool for managing labour potential, capable of ensuring the sustainable reproduction of professional competencies and stimulating the participation of the rural population in the innovative economy (Fursov, et al., 2018: 1955-1960).

An innovative education ecosystem is a combination of institutions, management mechanisms, technologies and partnerships between the state, business, science and society, aimed at creating conditions for the formation and realisation of intellectual potential (Taishykov, et al., 2023). In rural areas, it acts as a systemic driver, ensuring not only technological modernisation of the agricultural sector, but also social development of territories through education, employment and professional mobility.

The purpose of this article is to reveal the role of the innovative education ecosystem as a factor in managing the labour potential of rural areas, to determine the directions of its development and to outline the prospects for its application in Kazakhstan. Achieving this goal will deepen our understanding of the mechanisms of integration of education, innovation and management in the process of modernising the rural economy.

For rural areas, the innovative ecosystem plays a dual role: on the one hand, it modernises agricultural production, and on the other, it shapes new social and professional practices that help

retain labour potential.

Labour potential refers to the combination of quantitative and qualitative characteristics of the workforce, including the size of the working-age population, its level of education, professional skills, motivation and ability to adapt to working conditions (Nurzhanova, et.al., 2020: 656-671).

The following characteristics are typical of rural areas in Kazakhstan:

- a high proportion of the working population employed in the agricultural sector;
- limited access to quality education and healthcare services;
- migration of young people to cities;
- a lack of modern skills related to digitalisation and innovative technologies.

The development of an innovative ecosystem directly affects the quality of the labour force.

The introduction of new technologies requires the training of specialists with up-to-date knowledge, contributes to the formation of new professions (agro-IT specialists, agrocluster managers, drone operators, bioeconomists), and stimulates the retraining of personnel (Подгорская, 2021: 203-218). Moreover, innovation opens up opportunities for entrepreneurship and self-employment in rural areas, making rural areas more attractive to young people.

Thus, the theoretical basis of the study confirms that an innovative ecosystem is an important condition for increasing the labour potential of rural areas, and its development should be considered a strategic direction for state and regional policy.

Materials and methods. The study of the role of the innovation ecosystem in increasing the labour potential of rural areas was conducted using a set of complementary methods that ensure the scientific validity and reliability of the results. The use of a combination of theoretical and applied approaches made it possible to comprehensively examine the impact of innovation factors on human resource development in rural areas.

The methodological basis of the study was formed by the principles of systematicity, comprehensiveness, and the interconnection of socio-economic processes. At the theoretical level, methods of systemic-structural and logical analysis were used, which made it possible to consider the innovation ecosystem as a holistic system comprising economic, educational, technological, and institutional elements.

This approach made it possible to identify the internal logic of interaction between the elements of the ecosystem and determined the directions of their influence on the reproduction and development of the labour potential of rural areas.

The application of the theoretical generalisation method made it possible to clarify the content of the key concepts of `innovative ecosystem', `labour potential' and `innovative development of rural areas' and to establish their interrelationship. This ensured the methodological integrity of the study and made it possible to form a conceptual basis for analysing practical aspects.

At the empirical level, statistical and economic analysis methods were used to study the quantitative characteristics and dynamics of the processes under investigation. Indicators of employment, labour productivity, educational level of the population, innovative activity of enterprises, and investments in technological development of agriculture were considered.

The use of dynamic analysis made it possible to identify trends in changes in labour potential and innovative development in rural regions in recent years. Based on structural analysis, the proportions between the various components of labour potential - the qualification, age and professional structures of the employed - were identified, which made it possible to assess the impact of innovative processes on the quality of labour resources.

Thus, the use of a set of systematic, analytical, and comparative methods ensured the scientific validity of the study, made it possible to identify the relationships between the development of the innovation ecosystem and the formation of labour potential, and determined the directions for its further strengthening in rural areas of Kazakhstan.

Results and discussion. Despite the significant contribution of the agricultural sector to the economy, gross agricultural output in 2024 amounted to 8.36 trillion tenge, with a physical volume index of 113.6%, while the level of technological equipment remains low. Many farms continue to use outdated methods, and digital solutions are being implemented on a selective basis.

About 13.5% of the working-age population is employed in agriculture in Kazakhstan, but most workers have traditional skills and are not proficient in digital tools such as drones, GPS monitoring, and big data for yield forecasting. The skills gap hinders innovation. Meanwhile, the labour market is creating demand for new professions: agricultural drone operator, agricultural systems engineer, and agricultural IT analyst.

Over the past 12 years, more than 2.7 million people have moved from rural areas to cities, and the share of the rural population has decreased from 43.9% to 38.8%. In 2023 alone, more than 81,000 people left villages. Over the past 20 years, 1,404 rural settlements have disappeared, an average of about 70 villages per year. Migration reduces not only the number but also the quality of the labour force: villages are losing young people with high levels of adaptability and digital skills, which exacerbates the process of workforce ageing.

Rural areas face infrastructure deficits: internet access is limited, and educational and research centres are concentrated in cities. At the same time, the sector remains capital-intensive but less attractive to investors. The number of farms decreased by 5.4% (-14,400) in 2024, which indicates difficulties in accessing finance and low motivation to do business in rural areas.

Weak infrastructure and low investment support widen the gap between urban and rural areas. Even innovative ideas often remain unrealised here.

The regulatory framework is developing slowly, and coordination between government agencies, business and science is insufficient. At the same time, agriculture accounts for only about 4.1% of GDP, although it occupies a significant part of the country's territory.

Institutional fragmentation reduces synergies: universities, research centres, farmers and government agencies are not yet united in a sustainable innovation ecosystem.

In today's conditions, rural regions of Kazakhstan are experiencing a serious shortage of qualified and innovative personnel. The shortage of specialists is particularly acute in the agricultural sector, where around three thousand professionals are needed. The most sought-after specialists are those in applied fields — tractor drivers, machine operators, agronomists and other narrow-profile workers who ensure the effective functioning of the agro-industrial complex.

Despite the gradual development of educational and production initiatives, the human resource potential of the agro-industrial complex continues to decline. Currently, the number of workers with technical and professional education is 549,500, which is 4.6% less than in the previous year. An additional 255,500 workers have only primary or secondary general education, which also reflects a decrease of 2.9%. Particularly alarming is the decline in the number of specialists with higher and postgraduate education, whose share fell by 17.4% to 231,400 people (Table 1).

These trends point to the need to develop an innovative ecosystem capable of attracting skilled workers to rural areas, creating conditions for their professional growth and raising the overall level of labour potential. Such an ecosystem should bring together educational institutions, business structures, government bodies and research centres, ensuring synergy between the training of specialists and the real needs of the agricultural sector (Table 1).

Table 1. Employment of the population by education and age in agriculture, fisheries and forestry in the Republic of Kazakhstan (thousands of people)

Name	2022	2023	Increase
Total	1 119,0	1 036,4	-7,4%
by education			
Higher and postgraduate education	280,1	231,4	-17,4%
Technical and vocational education	575,8	549,5	-4,6%
Primary, basic, general secondary education	263,1	255,5	-2,9%
by age			
15	0,1	0,04	-60 %
16-24	121,7	111,7	-8,2%
25-28	105,6	89,1	-15,6%
29-34	190,5	169,0	-11,3%
35- 44	240,8	235,4	-2,3%
45-54	253,5	225,9	-10,9%
55-64	172,0	165,3	-3,9%
65 and older	34,7	40,0	15,3%

Note - Compiled by the author based on source data (Уровень занятости в секторе сельского хозяйства Казахстана снизился на 7% за год, 2024)

An analysis of the age structure of employment in Kazakhstan's agro-industrial complex shows that youth participation in agricultural production remains limited. The bulk of workers are concentrated in the 35 to 44 age group, numbering around 235,400 people, which significantly exceeds the number of young people under 29 in employment. There are 225,900 people working in the 45-54 age group, 169,000 in the 29-34 age group, around 165,300 in the 55-64 age group, and the proportion of workers over 65 does not exceed 40,000 people.

At the same time, young workers are gradually losing ground in the employment structure. Thus, the number of 15-year-old workers has fallen to 60, and the number of employed people aged 16-24 has decreased to 111,700, which is 8.2% lower than a year earlier. Only 89,100 people aged 25-28 are employed, which represents a 15.6% decrease over the same period. These data confirm the trend of an ageing workforce in rural areas and a decline in the influx of young professionals.

In this regard, the education system plays a key role in shaping innovative labour potential, primarily higher, technical and vocational education. It provides training for personnel who are not only able to adapt to modern challenges, but also to introduce innovative approaches to agricultural production.

At the same time, technical and vocational education provides practical training for workers needed to perform specific production tasks, from mechanisation and agricultural technologies to digital monitoring of agricultural processes (Shuvaev, et.al., 2019:1362-1367).

The combination of these levels of education within the innovative ecosystem of rural areas allows for the creation of a sustainable model for developing labour potential. Such an ecosystem not only contributes to the training of competent personnel, but also encourages young people to remain in rural areas and participate in projects related to the digitalisation, greening and modernisation of agriculture. As a result, education becomes not just a tool for employment, but a key element of sustainable innovative development in the region.

Table 2 - shows data on the number of technical and vocational education (TVE) institutions and the number of students in these institutions for the period from 2019 to 2023. The table shows both the absolute values of the indicators for each year and the difference in the number of institutions and students for this period.

Table 2. Number of TVE organisations and number of students

Indicators	2019	2020	2021	2022	2023	2023/2019 (+;-), %
Number of organisations (units)	740	737	724	718	711	- 29 - 3,92%
Number of students in TVE organisations (persons), of which:	475 443	477 539	494 042	525 909	547 994	+ 72 551 + 15,26 %
Number of students from rural areas:	98 764	103 240	99 344	106 112	100 238	+ 1 474 + 1,5%

Note - Compiled by the author based on source data (Техническое и профессиональное, послесреднее образование в Республике Казахстан, 2023)

Despite the reduction in the number of colleges, the technical and vocational education system (TVE) has demonstrated steady growth in student enrolment. Over the period in question, the number of students increased by 72,551, from 475,443 to 547,994, which indicates a growing interest among young people in technical and applied professions. The increased attractiveness of TVE is linked to improvements in the quality of training programmes, their adaptation to the needs of the economy, and the expansion of employment opportunities for graduates.

The dynamics of rural youth participation in the TVE system deserve special attention. Over five years, the number of rural students increased by 1,474 (approximately 15%). The highest figures were observed in 2022, after which the number of students from rural areas decreased slightly in 2023 to 100,238. Overall, there is a positive trend of growth in the involvement of rural youth in the vocational education system, which contributes to the improvement of human resources in rural areas (Техническое и профессиональное, послесреднее образование в Республике Казахстан, 2023).

Currently, the total number of students in Kazakhstan's higher education system remained relatively stable between 2019 and 2023, despite some fluctuations. At the same time, the number of educational institutions decreased by 29, confirming the trend towards consolidation of universities and optimisation of the higher education structure. The most noticeable changes concern the number of students studying under the rural quota. In 2019, universities enrolled 30,331 students from rural areas, while by 2023 their number had decreased to 18,323, indicating a significant reduction in this category of students.

This decline can be explained by a number of factors:

- A reduction in the number of higher education institutions, which limited the geographical accessibility of education for rural youth, especially if some of the closed institutions were located in regions with a high proportion of rural population;
- Adjustments to government policy on the distribution of rural quotas, which may have led to a reduction in the number of places allocated to applicants from rural areas;
- Socio-economic and demographic changes, including internal migration, urbanisation and a decline in the number of rural youth potentially interested in higher education.

At the present stage, there is increased demand in the country for specialists in various fields. According to analytical services, Kazakhstan needs approximately 2,817 teachers and about 3,900 doctors. Despite efforts to fill these staffing gaps, there remains a shortage of workers in other, equally important professional fields, especially in technical and blue-collar occupations that form the basis of the manufacturing sector of the economy.

The greatest demand for labour resources is predicted in sectors that ensure basic socio-economic development:

- education — approximately 331,000 workers,
- trade — 228,000,
- construction — 213,000,
- healthcare — 128,000,
- administration — 119,000,

- transport and logistics — 116,000.

There remains significant demand in agriculture, where it is predicted that around 114,000 specialists will be needed, as well as in manufacturing, where around 108,000 workers will be required.

These data indicate the strategic importance of an innovative approach to developing the labour potential of rural areas, which should be based on an effective vocational training system, the modernisation of educational programmes and the development of regional mechanisms to stimulate employment. Only through the integration of education, technology and social support can we ensure the sustainable reproduction of human resources capable of becoming the foundation of a competitive and innovation-driven economy in Kazakhstan.

The healthcare system is expected to see a significant increase in demand for general practitioners, dentists, paediatricians, surgical specialists, pharmacists, cardiologists, radiologists and gynaecologists. The shortage of medical personnel is particularly acute in rural and remote areas, where the lack of doctors directly affects the availability and quality of medical services.

Agriculture, while remaining a key sector of the national economy, also faces a shortage of qualified specialists. Among personnel with higher education, there is a particular shortage of agronomists, mechanical engineers, biologists, meteorologists, botanists, and production engineers. At the same time, in the blue-collar professions, the greatest demand remains for tractor drivers, agricultural machinery operators, feed procurement specialists and combine harvester maintenance specialists, which highlights the need for modernisation and technical upgrading of agricultural labour (Defitsit kadrov: kakie spetsialisty trebuyutsya v Kazakhstane, 2024).

Thus, personnel policy in rural areas of Kazakhstan should be based on the integration of an innovative approach to training specialists, developing the vocational education system, and digitising work processes. Only a combination of modernising the educational environment and supporting young specialists will make it possible to balance the structure of the labour force and ensure the sustainable development of the country's rural regions (Почти 4 тыс. педагогов не хватает в школах Казахстана, 2024).

Modern agriculture in Kazakhstan is actively moving towards technological transformation and digitalisation of production processes. An increasing number of agricultural enterprises are introducing intelligent and automated management systems, which opens up new prospects for the application of digital technologies in the agricultural sector. In this context, new professions are becoming increasingly important, such as agro-informatics and agro-cybernetics, which combine knowledge in the fields of information technology, engineering and agrobiology.

Although such specialists are still rare in the labour market, their demand is expected to grow in the coming years, given the pace of introduction of automated systems in agriculture (Профессия агроинформатик, агрокибернетик, 2024).

It should be noted that the rural labour market has a number of structural features. It is characterised by a mismatch between labour supply and demand, low levels of vocational training, weak receptivity to innovation and limited labour mobility. These factors hinder the development of human capital and impede the formation of a sustainable innovative labour force. At the same time, rural employment continues to play a key role in the market relations of the agro-industrial complex. However, there is a downward trend in the share of those employed in material production, accompanied by a simultaneous increase in the number of workers involved in the service sector, reflecting the processes of structural transformation of the rural economy (Bogdanova, et.al., 2019:5714-5717).

Thus, the development of the rural labour market requires a comprehensive approach, including the modernisation of vocational education, the introduction of innovative technologies, the digitalisation of production processes, and the creation of conditions to attract and retain qualified specialists in rural areas. These measures form the basis of an innovative ecosystem (Nurzhanova, et.al., 2023) capable of ensuring the sustainable development of labour potential and increasing the competitiveness of rural areas in Kazakhstan.

It is necessary to intensify cooperation between educational institutions and agricultural enterprises, industrial companies and business communities in order to develop a dual education

system that combines theoretical training with practical activities. This will enable graduates to acquire real professional skills and provide enterprises with ready-made specialists capable of working effectively in the modern digital and innovative economy (Uryadova, et.al., 2021: 609-617).

Thus, investment in education and human capital development is becoming one of the key factors in the sustainable development of rural areas. Not only does it help to increase the competitiveness of rural regions, but it also forms the basis of an innovative ecosystem in which young people have the opportunity for self-fulfilment and the rural economy receives a boost for renewal and growth.

Conclusions. The study made it possible to summarise the main trends and identify strategic directions for the development of the labour potential of rural areas in Kazakhstan in the context of forming an innovative education ecosystem. Based on the analysis of statistical data and the structure of employment, the following key conclusions were drawn:

1. The shortage of skilled personnel remains one of the central problems of rural areas. The shortage is particularly acute in the agricultural, engineering and medical sectors. The decline in the proportion of workers with higher and secondary vocational education reflects structural mismatches between the training system and the requirements of the rural labour market.

2. The age structure of the labour force is characterised by a trend towards ageing, which reduces the adaptive potential of the rural economy. The decline in the proportion of young people under the age of 29 requires the introduction of programmes to stimulate employment, provide career guidance and retain young professionals in rural areas.

3. The technical and vocational education system (TVE) is showing quantitative growth in student numbers, but qualitative indicators and the relevance of training remain insufficient. The decline in the proportion of rural youth in the TVE system indicates the need to improve educational policy, develop dual training and integrate employers into the process of training specialists.

4. The innovative transformation of agriculture creates a need for new competencies — digital, engineering, and analytical. Insufficient receptivity to innovation and weak digital training of personnel limit the possibilities for automation and the introduction of smart technologies in the agro-industrial complex.

5. Investment in human capital and innovative education is a strategic factor in the sustainable development of rural areas. The formation of an ecosystem of interaction between education, science, business and the state makes it possible to improve the quality of professional training, stimulate the influx of personnel to rural areas and strengthen the socio-economic stability of regions.

The practical significance of the study lies in the possibility of applying its results in the development of regional employment programmes and strategies for the development of the agricultural sector, taking into account the principles of innovative and inclusive education.

Prospects for further research are linked to an in-depth analysis of the effectiveness of regional educational initiatives, an assessment of the impact of digital skills on labour productivity, and the modelling of mechanisms for interaction between elements of the innovation ecosystem in the rural economy.

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