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Smart Agro-Clustering Based on the Chain "Education-Science-Business" for Sustainable Development

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Abstract

The rapid development of technologies has made their adjustments in absolutely all universe processes. The accelerating pace of technology development, and constant crisis phenomena direct all interested parties towards clustering. The study is devoted to studying theoretical and methodological developments regarding clustering, the analysis of the current state of the course of sustainable development chosen by Ukraine and the achievement of goals within its framework. A special place is given to the aspect of financial regulation of creating an agricultural cluster. The analysis showed the need to improve the established clustering chain by adding schools as cluster members at the initial stage. The authors proposed and clearly presented a scheme of interaction between stakeholders in a Smart-cluster and described why this agrarian cluster could be considered smart. The resulting synergistic effect of creating a cluster is not only in increasing the efficiency of its work as a whole compared to the efficiency of individual participants but also in the mutual strengthening of competitive positions. To improve the financial regulation of creating a smart agrarian cluster, the authors proposed an algorithm that would allow the most efficient allocation of money depending on priorities. Forecasting needs to be reviewed periodically because it is planned that at the initial stage, the smart cluster will be financed by “locomotives”, i.e. profitable industries/enterprises; in the future, financing will fall on the shoulders of promising highly profitable non-resource high-tech industries/enterprises.

Keywords: Agrarian clusters; Financial regulation; Clustering; Science education; Smart; Smartization; Sustainable development.

1. Introduction

The environment is continually changing: from the industrial age, society has long since gone digital, which has altered technologies, technical capabilities, management methods, consumer preferences, etc. The Fourth Industrial Revolution (Industry 4.0) and its technologies force companies to unite to obtain synergies, including reducing costs, increasing customer awareness, and sometimes just survival [1-3] Clusters can and should be used to solve practical problems of the development of economic entities.

The modern development of market relations in the agro-industrial complex forces us to look for innovative approaches to the organizational and economic mechanisms for managing technological processes in the agro-industrial complex; also, the agro-industrial complex in Ukraine is more unprofitable, with low profitability, which is why the authors focused the study on this industry since theoretical and methodological provisions on the creation of cluster structures for sustainable development can be of practical importance in the agro-industrial complex through the local development of the socio-economic system in the form of the formation of integrated systems based on the "education-science-production" chain. Thus, the purpose of the study is to study the prerequisites for the development of the Smart Agro-Cluster concept based on the education-science-production chain for sustainable development and its financial support.

Achieving the goal involves the consistent implementation of the following tasks:

- definition of the concept of "cluster", clustering;
- analysis of scientific approaches in the theory of clusters;

- analysis of the relevance and relevance of the subject of research in modern Ukrainian realities;
- development of the concept of creation Conceptual basis for creating a smart-cluster
- development of recommendations on financial regulation of the cluster creation.

2. Basis of Research

2.1. Theoretical and Methodological Review

The term "cluster" (a bunch, brush, group) has been used for a long time in many sciences, primarily natural. This term has been intensively used only in the last two decades in the economic and economic-geographical literature.

Clustering (or cluster analysis) breaks down a set of objects into groups called clusters. There should be "similar" objects within each group, and objects of different groups should be as diverse as possible. Clusters are usually grouped according to some criterion: belonging to an industry (agrarian clusters), peculiarities of activity (innovative orientation), spatial location (regional, regional, transnational) [4, 5].

At the present stage of development, the theory of clusters should be considered the most adequate to the requirements of regional industrial policy, ensuring sustainable economic growth rates and increasing competitiveness at all levels of management.

According to economists [6-8], such regional innovation-industrial clusters have several advantages over traditional industrial-sectoral forms of business organization.

Firstly, the stable system of disseminating new technologies, knowledge, products, and the so-called technological network, which is based on a joint scientific base, is of great importance.

Secondly, the cluster enterprises have additional competitive advantages due to the ability to carry out internal specialization and standardization to minimize the costs of introducing innovations.

Thirdly, the presence in the system of innovative industrial clusters of flexible entrepreneurial structures – small enterprises competing in producing creative ideas, makes it possible to grope for innovative points of growth in the regional economy.

Fourthly, regional industrial clusters are significant for the development of small businesses: they provide small firms with a high degree of specialization in serving a specific entrepreneurial niche since this facilitates access to the capital of an industrial enterprise and other resources, as well as an active exchange of ideas and transfer of knowledge from specialists to entrepreneurs.

There are three basic scientific approaches to cluster theory: American, British and Scandinavian.

1. The American approach is presented by the theoretical and conceptual studies of the most prominent American scientists. The theory of industrial clusters, proposed and formulated by M. Porter, reveals the concept of a "cluster" introduced in economic turnover by M. Porter himself, who interpreted it as "a group of geographically adjacent interconnected companies and related organizations operating in a certain area and characterized by common activities and complementary to each other" [9]. Thus, the size of cluster structures can vary from one city to several corresponding countries. At the same time, they represent a set of spatially neighbouring and territorially interacting large economic entities and interconnected entrepreneurial structures operating in a particular sector of the economy and are characterized by common approaches to management, similar or similar types of production and economic activities and their complementarity.

2. The British approach to building new forms of the spatial organization of the production process. This mechanism is based on three basic schemes for including clusters in the process of increasing the added value of goods and services:

- building a quasi-hierarchical chain with the inclusion of a cluster, which creates economically beneficial conditions and benefits for innovation in the production and technological process and product output;
- inclusion of clusters in the chain of production and economic relations in the regional (local) market, but with a relative slowdown in the innovation process in the production and technological environment and product output;
- the inclusion of clusters in business networks, which ultimately leads to improved production and technological processes, led to the release of competitive products.

Analyzing the British approach, we can state the following – building a cluster structure, in which an active role and place is given to small enterprises, increases its competitiveness primarily through the use of the mechanism for forming a chain of adding value for goods and services and changing the technical and economic development paradigm.

3. The Scandinavian approach to the construction and functioning of regional clusters is focused on developing the theory of the economics of learning and the national system of innovations.

The theory of the economics of learning is based on the postulate of creating innovations and generating new knowledge, which, in fact, becomes the only effective instrument for increasing the level of competitiveness of economic entities, clusters, regions and individual countries. Lundwall introduced the concepts of “incremental innovation” [10] and “learning economics” [11] into economic circulation and studied such an economic phenomenon as the national system of innovations, which is a sizeable spatial-territorial entity, including manufacturing enterprises and the established mechanism of relationships between them; sector of the state economy; development institutions; formation and development of a system of scientific research and experimental design work (R&D); organization of the education and training system [12-14].

The author believes that not a single method will bring the desired effect in current conditions in its pure form, but the proposals will be based on the Scandinavian approach.

2.2. The Relevance of Research

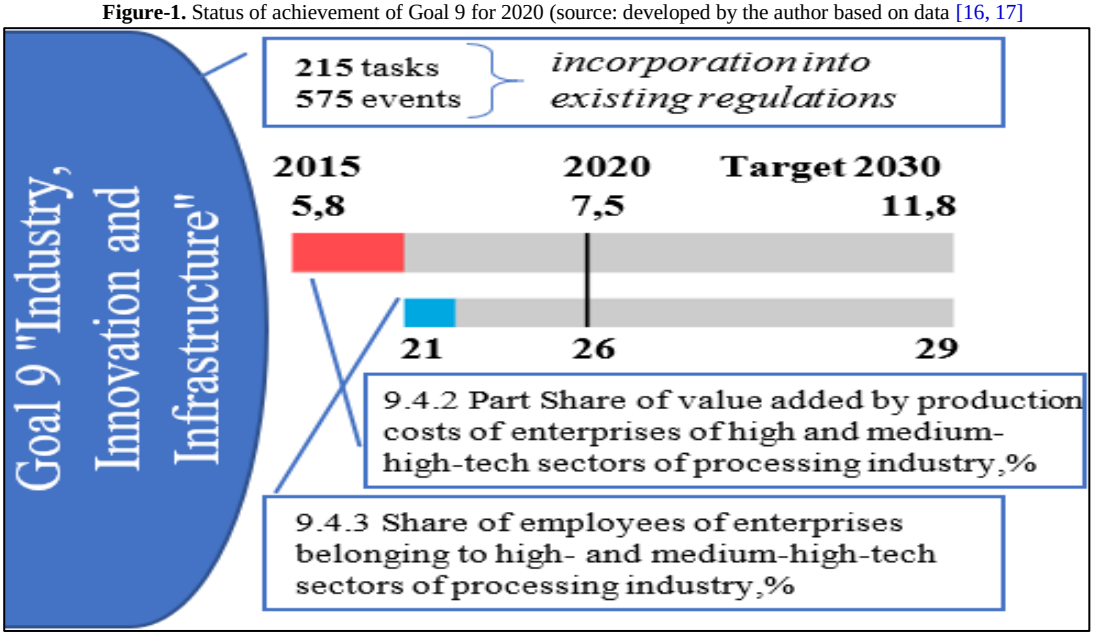
In September 2015, at the UN Summit in the framework of the 70th session in New York, ways of further sustainable development were considered, which resulted in the identification of 17 goals and 169 targets in the field of sustainable development in the document "Transforming our world: an agenda for sustainable development until 2030". Like other UN member states, Ukraine has joined the global process of ensuring sustainable development.

Thus, Goal 8, "Decent Work and Economic Growth", states that "the basis of structural and innovative transformations should be… innovation axis of priority industries, which will be domestic flagships in the implementation of innovative technologies and around which modern clusters will be formed…" [15].

Goal 9, "Industry, Innovation and Infrastructure", contains Task 9.4. "Promote the accelerated development of high- and medium-high-tech sectors of the processing industry, which are formed through the use of chains "education – science – production" and a cluster approach in the areas: development of innovation ecosystem" [15]. Still, we believe that this is relevant not only to the processing industry.

In terms of the number of CSR incorporations into existing regulations (state strategies and program documents), Goal 9 is the leader. Still, only 2 of its indicators have a positive development dynamic (Fig. 1).

Figure-1. Status of achievement of Goal 9 for 2020 (source: developed by the author based on data [16, 17]



Ukraine also sees the development of its strategy for using European programs, including the "European cluster program".

3. Results

3.1. Conceptual Basis for Creating a Smart-Cluster

The theoretical and methodological analysis showed that the emphasis should be placed on the cluster participants, the forms and features of their interaction, and financial regulation and assessment indicators.

The Fourth Industrial Revolution introduced many changes, one of which was cadres. It is expected that by 2050 the relationship with workers will radically change; many professions will cease to exist, others will replace them, and most will be robotic, but the main threat posed by the Revolution is the lack of qualified specialists. Technologies are developing rapidly, and today's Ukrainian education does not keep up with them: students often receive knowledge divorced from reality. There are several reasons for this: incompetent teachers (there is no means or desire to improve themselves, to understand current changes; teachers have nowhere to get the opportunity to give practical skills because they have not encountered them in practice), inadequate material support (you cannot train specialists on outdated equipment, which is not used); business structures see no reason to cooperate with universities, etc.

Separately, it is worth noting the student's unwillingness to acquire knowledge since many did not act according to their wishes. Still, according to their parents' wishes, it was much closer and easier, etc. Many people do not even know many professions in principle; therefore, they often change the speciality of training in the last courses of study (magistracy). This is due to universities' insufficient vocational guidance, lack of government support, and unwillingness to involve future employers because not so many of them face incompetent personnel.

However, the interaction should not start with the student but much earlier - with the student and even the elementary grades. Science education is used for this abroad.

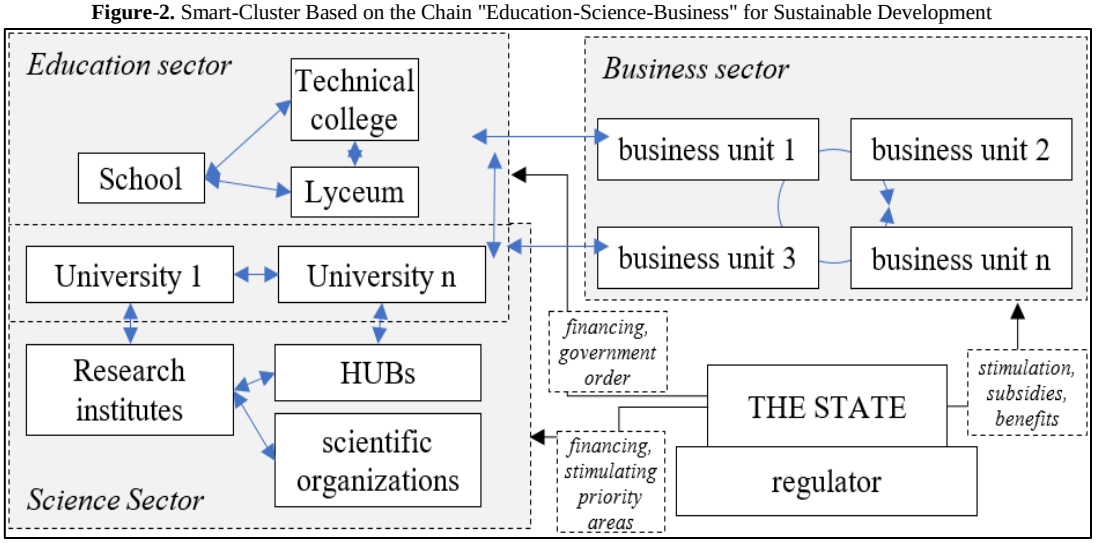
Science education has long been a global trend. Scientists are exploring new ways of teaching students and teachers and popular science lectures. Scientific research is both the study of facts and the mastery of the scientific

method, that is, the ability to build a structure from bricks; these facts follow specific rules. In scientific research, logical and structural reasoning, hypotheses, modelling of phenomena, assumptions, tests, and studies should be examined that can refute or confirm previous assumptions.

In the education system we inherited from Soviet times, the creativity, creativity and freedom needed to learn certain things were not part of compulsory education. This opportunity was available only to university graduates who opened up space for scientific creativity. Foreign science education is more advanced – it teaches natural sciences and scientific methods to non-scientists: children, students, adults who are not engaged in science.

Thus, training should start at school. It follows from this that a modern cluster should look like this (Fig. 2).

Figure-2. Smart-Cluster Based on the Chain "Education-Science-Business" for Sustainable Development



Source: Developed by authors

Let's consider why the presented cluster is a Smart-cluster.

Smartization is a purposeful introduction of optimal latest world achievements in innovation for efficient use of resources, increasing all business processes' synergetic efficiency to effectively achieve goals in the short and long term in a continually changing environment.

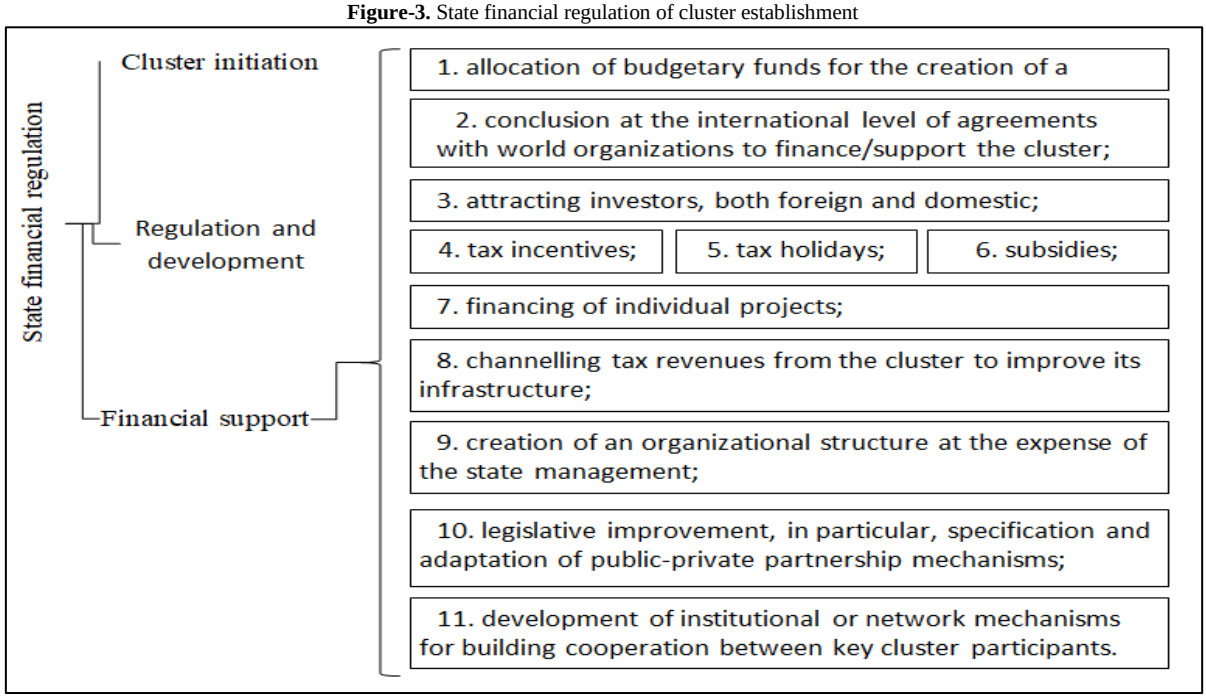
That is, the introduction of innovative technologies should be purposeful and effective tested. This is the effect the presented cluster gives. A distinctive feature is the interaction of not one school or university but their group. It would seem that universities should cooperate with different clusters to get top positions individually.

However, we believe that some adjustment is needed in the training of specialists, namely, its concentration in 1-2 universities, so that there is no unfair competition among universities for students in a speciality, for example, the hotel and restaurant business, such specialists should be trained by one, maximum two universities, if there is an individual specificity. Schools should also cooperate with lyceums and colleges so that those students who have already decided on a profession can immediately begin to build a professional career. Teachers often combine teaching and research activities, and the cooperation of universities with research institutes and scientific institutions will significantly facilitate teachers' scientific activities and allow them to advance in their research qualitatively. In this interaction, the participation of the state is mandatory; it should act as a regulator, namely, to finance necessary strategic research, increase/decrease the state order depending on the specialists existing on the market, and reduce taxation of enterprises to stimulate them to cooperate with the sphere of education and science. This point of cooperation makes it a Smart-cluster and allows you to achieve an even more significant synergistic effect.

3.2. Financial Regulation of Cluster Creation

Having analyzed the possible options, we concluded that the creation and successful operation of the cluster depends on the comprehensive support of the state. This support includes (Fig. 3).

Figure-3. State financial regulation of cluster establishment



Source: developed by the author

The activities for the practical implementation of the cluster policy and strengthening its financial component have a cross-sectoral focus, and the implementation provides for close interaction of public authorities, local government and business.

In order to develop a financial mechanism for the development of smart clusters, it is advisable to analyze the experience gained abroad (Table 1).

Table-1. Mechanisms of financial support of innovative processes in territorial clusters of foreign countries

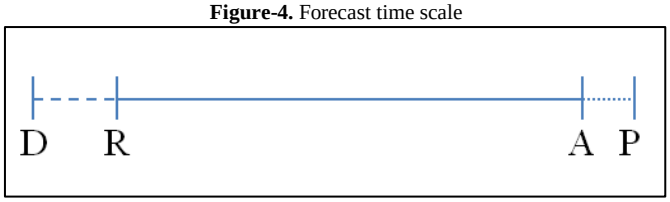
Country	Financial support mechanisms
USA	The presence of a federal contractual system, based on which innovative companies that are part of territorial clusters are provided with the following opportunities: - free use of industrial equipment and government laboratories for research; - provision of tax incentives; - provision of benefits when purchasing raw materials and materials from state suppliers; - the possibility of early depreciation of fixed assets; - subsidizing own developments of innovative companies.
Japan	- provision of grants; - a large number of credit funds provided to innovative companies in clusters; - reimbursement of expenses for registration of patents; - provision of incentives for the creation of small innovative companies based on universities, research institutes and centres of technological development.
Germany	The organization of innovative activities of companies in territorial clusters is carried out based on the use of mechanisms of state partnership. The institutes for the development of innovative activities, together with the state bodies of the federal states, implement a cluster policy, contribute to the implementation of state programs and the provision of subsidies to clusters at the expense of the budget of the federal states.
Netherlands	- no import and export duties; - tax on profits from export operations is 2%; - no sales tax; - no taxes on real estate and property; - deliveries to the domestic market of the Netherlands Antilles are subject to import duties and income tax in force in the country but cannot exceed 25% of the total sales; - retail trade is prohibited.
India	In the development of clusters, funds from international funds are used. A national cluster program for the development of small and medium-sized enterprises has been developed, support for cluster initiatives has been organized, and cooperation has been established with key national institutions and banks. The significant role of technology parks in developing innovation clusters, including stimulating innovative internal developments and their exemption from excise taxes, concludes agreements to accelerate the innovation process.
France	Clusters are created through partnerships between local industry groups, universities and research institutes. Clusters are supported jointly by local authorities and regional departments of the Ministry of Economy, Finance and Industry.

As you can see from the table. 1, the largest share is occupied by indirect methods of supporting innovation. In addition, in foreign countries, development institutions play an essential role in developing and financing innovation

processes in territorial clusters. Some of the indirect support measures are also common in Ukrainian practice, such as the possibility of using accelerated depreciation of fixed assets, obtaining an investment tax credit, and exemption of companies from VAT on activities related to research and development.

Thus, the financial regulation of the cluster must be planned, taking into account the state of the economy, the global pandemic and other crises. The logical sequence of forecast development involves implementing seven stages (Fig. 4).

Figure-4. Forecast time scale



For each specific case, there are three characteristic points:
R – reference point;
P – the point of the predicted occurrence of the event;
A – the point of realization of the event;
D – a moment in time in the past that determines the depth of retrospection of information.
RP – lead time;
AP – forecast error (absolute);
RA – real time of the event;
RD – the time of functioning of the object in the past or the time of the basis of the forecast.

Any forecast is characterized primarily by the time (anticipation) and specific indication of the object's parameters. A time scale is used to measure the lead time, which is a line on which characteristic points are plotted on a time scale (Fig. 5).

Figure-5. Algorithm for developing a forecast of financial regulation of the creation of a cluster (source: developed by the author)

1	Predictive orientation based on the system-structural analysis of the forecasting object.
2	Statement of the problem for the development of the forecast.
3	Analysis and establishment of active factors of the forecast background.
4	Formation of the information base on the object of the forecast and the forecast
5	Drawing up a forecast model and the choice of forecasting methods.
6	Development of a forecast for the growth of an object and an assessment of its reliability, taking into account the action of the factors of the forecast background.
7	Formulation of recommendations for making planning decisions based on the forecast.

The formula calculates the predicted value of the parameter (Yt):

$$Yt = yt + Et \qquad (1)$$

where *yt* – the real value;
Et – the magnitude of the error.

Minimizing *Et* can be achieved by reducing the effect of the noise level on Et and determining the relationship between the error and the prediction base time. In the forecasting process, there are mainly four types of errors:

$$Et = Ei + Em + Ev + En \qquad (2)$$

where *Ei* – the error of the initial data;
Em – error of the forecast method (or model);
Ev – inaccuracy of calculations;
En – irregular error (the appearance of unpredictable events).

Next, the forecast verification procedure is carried out. Verification is the procedure for assessing the reliability of a forecast. With its help, it is possible to determine the reliability of the forecast with a sufficiently high degree of probability for practical recommendations. We believe that verification in the case of a prediction of financial regulation should be carried out in one of 2 ways:

Consequent verification – obtaining the value of a verified forecast by logical (or mathematical) derivation of consequences from already known forecasts.

Inverse verification is carried out when there is a set of forecasts of objects by year, starting from the present time and up to a certain time horizon in the future.

This methodology for forecasting the financial regulation of a smart cluster will allow the most efficient allocation of money depending on priorities. Forecasting needs to be reviewed periodically because it is planned that at the initial stage, the smart cluster will be financed by "locomotives", i.e. profitable industries/enterprises; in the future, financing will fall on the shoulders of promising highly profitable non-resource industries/enterprises.

3. Conclusions

Clustering development trends indicate the relevance and success of this concept in the practical experience of many countries. To date, no unified concept for building clustering mechanisms has been developed; however, each country has identified its own set of successful practices for implementing elements of cluster policy, taking into account national characteristics.

The cluster approach has grown into an essential tool for forming and implementing municipal economic policy. Clusters have become one of the main driving forces and determinants of competitiveness, the effectiveness of which has been confirmed by world experience. They make it possible to increase the competitiveness of their enterprises and specific industries, expand the introduction of innovations, reduce transaction costs, and develop and strengthen relationships between business, science, education, and the state. The resulting synergistic effect from the creation of a cluster increases the efficiency of its work as a whole compared to the efficiency of individual participants and the mutual strengthening of competitive positions.

The main expected results of the development of the Smart-cluster can be:

1. increasing the competitiveness of business entities due to an increase in production volumes, the share of innovative products and labour productivity at enterprises participating in clusters;
2. growth of non-resource and high-tech exports of goods;
3. intensification of the development of innovative business entities;
4. development of individual entrepreneurship, an increase in the number of small and medium-sized enterprises;
5. increasing the percentage of localization of the production of competitive products;
6. Formation of an effective policy of training and retraining of professional and highly qualified personnel for organizations working in clusters;
7. growth of attracted direct domestic and foreign investments.

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