Integration in breeding and seed production through the formation of regional systems

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Abstract. The authors study methodological approaches to the formation of regional systems of breeding and seed production, critical for agrarian development. The aim of the work was to substantiate the necessity of transition from a fragmented approach to integrated regional systems combining scientific institutions, production enterprises and state structures. The study revealed that the existing seed production system in Russia is characterised by high dependence on imported seeds and insufficient efficiency. The authors proposed a concept of a regional system based on co-operation and integration, including innovation, production and market subsystems. A non-profit association is proposed as an organisational form to facilitate the coordination of activities and attract investment. The results of the study show that the implementation of the proposed model contributes to improving the efficiency of breeding and seed production, and ensures sustainable development of the agricultural sector.

1 Introduction

One of the most important elements determining the success of agricultural production is breeding and seed production. Creating high-yielding and disease- and pest-resistant varieties and hybrids, as well as providing them with quality seed are fundamental tasks, the solution of which directly affects the efficiency of the entire agriculture.

There are several main approaches to solving problems in the field of breeding and seed production. One of them is the development and support of large research centres engaged in plant breeding and genetics. These centres have the necessary human and technical capacity to develop new varieties and hybrids adapted to specific regional conditions. However, they are often disconnected from real production processes and are not always able to effectively translate their achievements into practice [1, 2]. Another approach is to develop the private seed sector, stimulating competition and innovation. This approach can improve seed quality and reduce seed costs, but can also lead to market concentration and dominance by large players. The third way is to develop co-operation and integration between research institutions, production enterprises and government agencies. This approach can ensure more efficient interaction between all actors involved in the process and facilitate faster introduction of new technologies into practice. Each of these approaches has advantages and disadvantages. The development of large research centres helps to concentrate resources for basic research and development of new technologies. However, without proper linkage with production, their developments may remain unused. Private seed production based on market mechanisms promotes competition and price reduction, but may be oriented towards maximising profits at the expense of seed quality. Cooperative forms of integration can be effective but require alignment of interests of different groups and organisations. At present, there is an obvious need to find a balance between these approaches to achieve sustainable development of the seed industry [3, 4].

The relevance and importance of this direction lies in the fact that it offers a model of transition from individual seed production centres to the formation of complex regional systems based on the integration of various participants. This approach allows for the creation of a sustainable and flexible structure that can adapt to rapidly changing market conditions and regional specificities. This is especially important for such a large country as Russia, with its diversity of climatic zones and agronomic conditions [5]. Moreover, the author's approach assumes the consideration of innovation models as dynamically developing sub-sectors of the economy, which implies the need for continuous improvement and adaptation of technologies, as well as the introduction of resource-efficient agro-technologies. It is important to note that this approach not only takes into account organisational issues, but also offers economic models based on the contractual form of network organisation, which allows to ensure the

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sustainability and financial attractiveness of these systems.

The aim of the work is to substantiate methodological approaches to the formation of regional systems of breeding and seed production, as well as the development of organisational models that contribute to the effective functioning of these systems. The work is aimed at identifying and analysing the cause-and-effect relationships that constrain the institutional development of this sub-branch in Russia, and suggests ways to solve them by creating effective regional systems. The study considers the potential of new technologies and agro-technologies in increasing crop yields and reveals the importance of the system approach for the development of the seed industry.

2 Method and materials

In this work, a comprehensive methodological approach was used, including the analysis of literature sources and conducting our own research to develop a model of the regional system of breeding and seed production. The experimental part of the work consisted in the study and generalisation of experience of various forms of organisation of breeding and seed production activities, as well as in the development and analysis of organisational models that can ensure effective interaction between the participants of the process.

In the process of the study, the system approach was applied, which implied consideration of seed production as a set of interrelated elements: scientific institutions, production enterprises, state and business structures. General scientific methods such as comparison, generalisation and systematisation were used for the analysis of organisational models. Methods of economic and mathematical modelling were used in the development of economic models. In particular, various options of contractual relations between the participants of regional systems were considered in order to determine the most effective forms of integration.

3 Results and discussion

The presented research is aimed at analysing a critical aspect of agrarian development - the formation of effective regional systems of breeding and seed production [6]. In contrast to a fragmented approach, where individual centres of elite seed production function in isolation, this study promotes the idea of integration and cooperation. The focus is on the transformation of disparate structures into a single, dynamic network. This network should bring together research institutions, production enterprises and public authorities, thereby providing an integrated and synergistic effect. At the same time, this study is not limited to organisational aspects only, but also addresses the economic feasibility of the proposed models. The methodological basis of the study is the application of analytical methods and modelling. This involves a detailed analysis of the current state of breeding and seed production in Russia, identification of root causes that hinder the development of the industry, and on this basis, the construction of a conceptual model of the regional system. This model is not a static scheme, but a dynamic mechanism capable of self-development and adaptation. An important element of the model is the emphasis on horizontal and vertical integration between different actors, as well as on the transfer of advanced agro-technologies and scientific knowledge.

The concept of the regional system of breeding and seed production proposed in this paper goes beyond traditional approaches. It is not reduced to a simple merger of existing structures, but represents a fundamentally new model in which science and practice work in close co-operation. This model envisages the creation of specialised production sites, such as pilot and base farms, demonstration plots, and other elements that support the entire seed production cycle from basic research to commercialisation (fig. 1). The key idea is that the system should not only produce seed, but also provide technological support and scientific knowledge to accompany this process, enabling farmers to maximise the potential of new varieties and hybrids. The proposed model also emphasises the dynamic nature of the system, which should continuously improve and adapt to changing market conditions and technological challenges [7, 8]. For this purpose, it is supposed to attract private capital, as well as to stimulate the initiative of local entrepreneurs. At the same time, the system should be economically self-sufficient and attractive to investors, which is achieved through contractual forms of network organisation. At this stage of the study, an important aspect is to conduct a detailed economic analysis of the proposed model, including an assessment of its potential profitability and payback period.

Analysis of the results clearly shows that the existing seed production system in Russia does not meet modern requirements and needs deep modernisation. Excessive dependence on imported seeds, reaching 90% for some crops, indicates the weakness of the domestic breeding and seed industry and threatens the food security of the country [9, 10]. It also leads to an increase in the cost of agricultural products and reduces the competitiveness of Russian farmers. Therefore, the authors propose a transition to an integrated approach, where the regional system of breeding and seed production functions as a single organism, including three interrelated subsystems: innovation, production and market. The innovation subsystem focuses on fundamental research and development of new varieties and hybrids adapted to specific regional conditions, using modern biotechnological and genetic methods [11, 12]. The production subsystem is engaged in multiplication of seeds of higher reproductions, using advanced agro-technologies that ensure high quality of seed [13]. The market subsystem is engaged in the promotion of seeds on the market, knowledge transfer and technological support to end users. According to Rosstat data for 2022, the share of domestic seeds in the market of cereals is only 35%, vegetable seeds 20%, sunflower seeds 50%, and potatoes 15%. These figures clearly indicate the need for major changes in the seed industry.

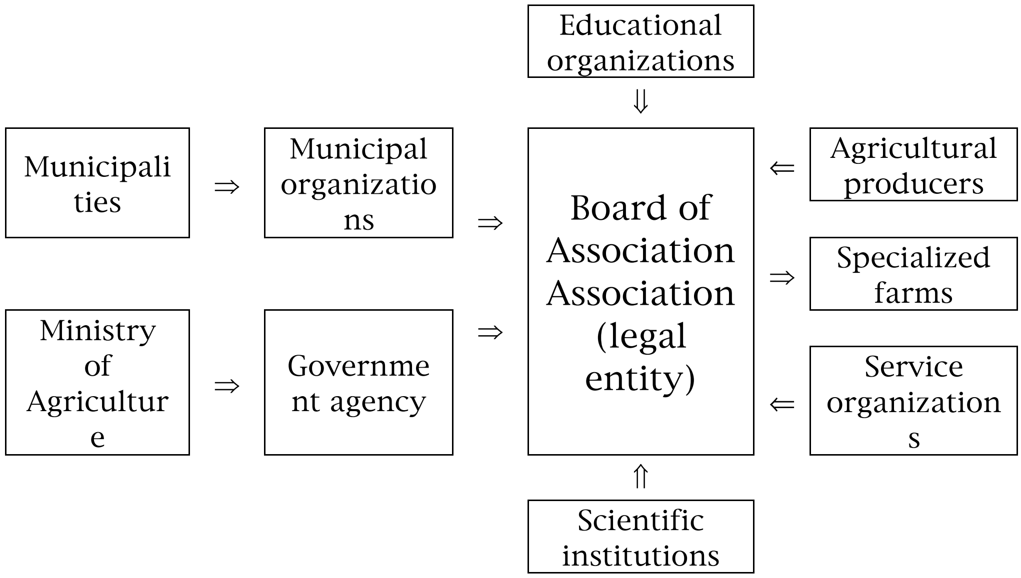

Figure 1. Scheme of the regional system of breeding and seed production in the form of an association

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The proposed models of cooperation in breeding and seed production, based on the integration of scientific, production and governmental structures, have already proved their effectiveness in practice, both in Russia and abroad. One of the vivid examples is the experience of the Netherlands, where seed production is developing within the framework of close cooperation between universities, research centres and private seed companies. Such co-operation allows Dutch companies to occupy leading positions in the world seed market. For example, Bejo Zaden, a company specialising in vegetable breeding, actively cooperates with Wageningen University, which allows them to quickly implement new developments and create high-yielding hybrids. According to 2023 data, Bejo Zaden produces more than 170 thousand tonnes of vegetable seeds annually, exporting them to more than 100 countries, accounting for more than 30% of the global onion seed market.

In Russia, a positive example of co-operation is the activity of research and production associations (NGOs) in the Soviet period. For example, the NGO Kuban was engaged in breeding and seed production of winter wheat, which allowed the development of a number of high-yielding varieties, such as Bezostaya 1 and Aurora. As a result of their work, wheat yields in the Krasnodar region increased by 40-50% compared to the pre-war period, reaching 5-6 tonnes per hectare in some farms. The NGO ‘Podmoskovye’, specialising in potato breeding, created varieties resistant to phytophthora, which reduced yield losses from this disease by 20-25% in the central regions, yielding up to 30 tonnes per hectare in some farms.

Modern examples also demonstrate the effectiveness of co-operation. Gavrish, although a private company, actively cooperates with scientific institutions, as well as with farms, which allows them to create varieties and hybrids adapted to specific conditions. At the moment, the Gavrish seed catalogue has more than 2000 names, which provide a significant share of greenhouse vegetable growing in Russia, and are also exported to the Middle East and Europe. According to our data, based on surveys of farms, the use of seeds of varieties and hybrids ‘Gavrish’ in greenhouse farming allows to obtain 15-20% higher yields compared to the use of imported analogues, as well as to reduce the growing time by 10-15 days [18]. In the context of the proposed model, the results of the work indicate the need to create such regional structures based on cooperation and partnership. The most promising organisational form seems to be the association of a non-profit organisation, which can combine the resources of different entities and ensure coordination of their activities [19]. This will allow to create a sustainable and flexible system that can effectively solve the problems of breeding and seed production in specific regions. However, at this stage, an important factor is to carry out detailed economic calculations to confirm the financial feasibility of this model. Based on the data obtained, the authors conclude that there is a need for a systematic approach to the development of breeding and seed production, where research and production practice are closely linked.

4 Conclusion

This study emphasises the critical need to reform the existing system of breeding and seed production in Russia. The results of the work convincingly demonstrate that fragmented and non-integrated approaches to seed production lead to excessive dependence on imports, reduce the competitiveness of domestic agricultural producers and jeopardise the food security of the country. Based on the analysis, the authors justify the need to move to a systemic approach based on the integration of scientific research, production practices and government regulation.

The key conclusion is the proposal to form regional systems of breeding and seed production, which should be unified dynamic complexes that unite research institutions, production enterprises, government agencies and other stakeholders [20, 21]. This system should include innovation, production and market subsystems, each of which fulfils its specific function. Important is the emphasis on contractual forms of network organisation, which will ensure the financial sustainability and attractiveness of these systems for investors. At the same time, the non-profit form of the association seems to be the most promising, as it ensures transparency and sustainability.

Summarising the results obtained, we can state that the model of the regional system of breeding and seed production proposed in this paper is not only theoretically justified, but also practically applicable. It allows to create a flexible and adaptive structure that can effectively solve the problems of breeding and seed production in different regional conditions. At the same time, for successful implementation of the proposed model, further work is required to develop specific methodological recommendations that take into account the specifics of each region.

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