Rural area infrastructure as a factor in the development of organic farming

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Abstract. This paper analyzes the impact of rural infrastructure in the regions of the Siberian Federal District on the organic farming development. Authors determine that the Novosibirsk and Omsk regions and southern part of the Krasnoyarsk Territory are characterized by the most favorable conditions for the organic farming development in terms of engineering, transportation and social infrastructure. The infrastructure is relatively well developed in the Altai Territory, the Republic of Khakassia, Kemerovo, Tomsk, and Irkutsk regions. Weak infrastructure development characterizes the Republics of Tuva and Altai, as well as remote areas of the Krasnoyarsk Territory, Irkutsk, and Tomsk regions. The primary mechanisms by which infrastructure influences the organic agricultural sector development are: reducing transportation and transaction costs and increasing profits in producing high-value-added products close to cultivation areas, enhancing the attractiveness of rural employment for skilled professionals, and generating solvent demand among the local population. The article proposes various options for increasing the efficiency of government and business actions in rural areas, including public-private partnerships for implementing infrastructure projects, associated training contracts, institutionalization of remote jobs, government procurement of organic agricultural products with advantages for local agricultural producers.

1 Introduction

In the modern world, any form of production, including agriculture, cannot exist without the infrastructure that supports its activities. The impact of infrastructure on economic activities is multifaceted, and the following key directions can be identified:

1. Provision of essential services – finance, consulting, housing and utilities, etc.
2. Enhancing attractiveness for skilled professionals.
3. Development of transportation and storage.
4. Workforce development.
5. Marketing of finished products.

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This list is not exhaustive, but for the purposes of this article, we will limit ourselves to these points.

Organic farming places increased demands on rural area infrastructure due to its specific requirements. Being more demanding in terms of employee qualifications and diligence, organic agriculture often needs to attract specialists to rural areas who require a higher quality of life than what the local population considers normal [1]. Additionally, organic farming is more high-risk and capital-intensive than conventional farming, requiring broader access to banking and insurance services. The need for organic product certification gives rise to a separate type of supporting infrastructure - certification infrastructure. Furthermore, organic production is typically oriented towards external markets, making information and communication infrastructure critically important in conveying product information to consumers and informing producers about market requirements, new laws, technologies, and more. Finally, the cost of producing one unit of organic product is higher than that of conventional products, making it more important to reduce potential losses during transportation, thus increasing demands on transportation infrastructure.

From the above, it is clear that organic farming places higher demands on rural area infrastructure compared to traditional agricultural activities. Next, we will examine the problems and prospects in this regard within the Siberian Federal District (SFD).

2 Materials and methods

The methodological basis of this study was a systematic analysis of existing information in the field of development of organic farming and production resources of the subjects of the Siberian Federal District (SFD). On the basis of open statistical information, the following types of infrastructure are considered: engineering (the state of engineering networks of rural settlements), social (health and education institutions in rural areas), transport (the availability and quality of the road and railway transport network), household and service (localization of facilities and assessment of the availability of services). The information base of the study was statistical and analytical materials of government agencies [2-5, 7, 11], as well as materials of scientific papers [1, 6-8, 10] describing summary information on the subjects of the SFD. The results of the study were obtained on the basis of content analysis and data processing by statistical methods. Computational-graphical and abstract-logical methods of data analysis were also used in the work.

3 Results and discussion

Rural areas in the Siberian Federal District are characterized by uneven development and relatively low population density (3.9 people per square kilometer, which is 15.5 times lower than in the Central Federal District) [2]. This has an impact on the state of infrastructure and, ultimately, on the agricultural sector. For example, banking services, essential for the development of modern businesses, are mainly available in district centers in rural areas, and the vast majority of these organizations are branches of Sberbank [3], indicating low competition in the rural banking sector. These factors complicate the interaction between rural businesses and banks and increase transportation and transaction costs for rural producers.

The engineering infrastructure of rural settlements can influence the development of organic farming through three main channels. Firstly, it directly affects production by providing gas, water, heat, etc. Secondly, the development of infrastructure, including engineering infrastructure, makes rural areas more attractive (or, more accurately, less unattractive) for the migration of highly skilled specialists, who are needed in organic

agriculture more than in conventional farming [1, 6]. Thirdly, infrastructure facilities create jobs with higher wages than in agriculture, increasing the financial income of the rural population and creating a solvent demand for organic products in local markets. Some indicators of the state of engineering infrastructure in rural areas of the Siberian Federal District in 2021 are presented in Figure 1 [4, 5].

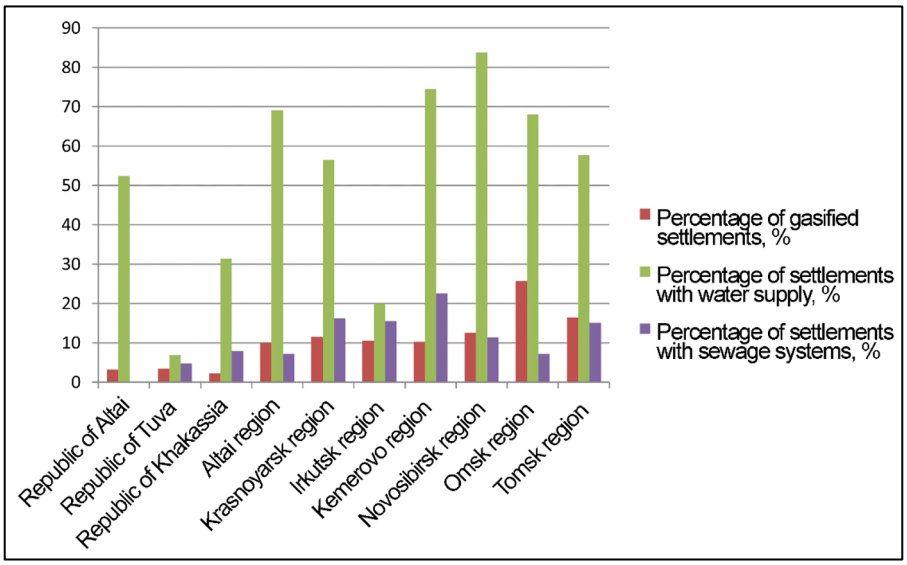

Fig. 1. Availability of engineering infrastructure in rural settlements of the Siberian Federal District.

As seen in Figure 1, the main problems common to all the considered regions are the underdevelopment of sewage networks and low levels of gasification. The Omsk region has the highest level of gasification in the district, but even there, as of 2021, only 25.73% of rural settlements were gasified. The worst situation regarding gasification is in the Republics of Altai, Tuva, and Khakassia, where the level of village gasification is less than 5%. These same regions are among the least provided with sewage networks. Only in the Kemerovo region do more than 20% of rural settlements have sewage networks.

Water supply networks are most developed in rural areas of the Novosibirsk region, where 83.8% of rural settlements have centralized water supply. Water supply systems are relatively well-developed in the Kemerovo and Omsk regions, as well as in the Altai Territory (ranging from 68% to 74%). The lowest level of water supply network availability is observed in the Republic of Tuva (6.94%).

These indicators of engineering infrastructure were chosen by the authors because they are the limiting factors for rural economic development. While the level of electrification in rural areas has remained high and sufficient for production since Soviet times, the underdevelopment of other components prevents the development of high-tech industries, such as processing and the production of finished products, rather than just raw materials. Additionally, it reduces the migration attractiveness of rural areas. While the existing level of infrastructure development may seem sufficient for the daily needs of the rural population, the requirements of enterprises are significantly higher. Therefore, the level of engineering infrastructure development is one of the important factors in choosing a location for activities.

One of the main differences between organic production and conventional production is the higher demand for human capital. More details on this issue are discussed in [6, 8]. For now, let's emphasize that qualified specialists are more demanding not only in terms of engineering infrastructure but also in terms of social, domestic, and leisure infrastructure. We

will examine some indicators that characterize the attractiveness of rural areas for qualified specialists, who are needed both directly in the field of organic farming and in the supporting infrastructure.

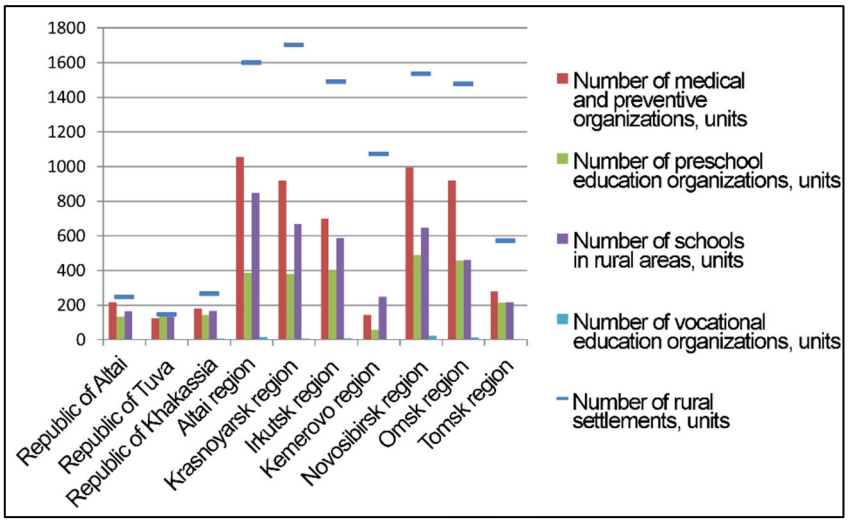

Fig. 2. State of social infrastructure in rural areas of the Siberian Federal District in 2021 [5, 7].

From Figure 2, it may appear that rural areas in the Siberian Federal District are fairly well-equipped with healthcare facilities. However, in reality, most of them are rural medical centers where rural residents can only receive primary medical care. Specialized medical care is only available in district centers. Additionally, due to the wage payment system for medical workers, one paramedic or general practitioner may work at multiple rural medical centers, splitting their presence throughout the week.

The network of schools in rural areas is genuinely well-developed. Despite the fact that many of them are small-scale, the educational system covers the entire region, although in some regions, such as the Republics of Altai and Tuva, there are still issues with transporting students to school. However, access to preschool education leaves much to be desired. As of 2021, the worst situation was in the Novosibirsk (47.75%) and Irkutsk (50.06%) regions. The highest proportion of children covered by preschool education is in the Tomsk region (70.62%), as well as in the Republics of Khakassia (67.75%) and Altai (67.37%) [7, 8]. Therefore, workers engaged in organic agriculture do not have guarantees of childcare during their work. This situation is further complicated if the worker comes from another settlement and has no relatives available to provide childcare.

Another issue is obtaining education after completing school. Higher education institutions are primarily concentrated in cities, and vocational education institutions in rural areas are located in district centers, reducing both the transportation and financial accessibility of educational services for rural residents [6, 8]. This makes it difficult to develop the necessary human capital directly in the areas where it would be most applicable in organic farming.

Also, an essential element in attracting and retaining personnel for organic agriculture is domestic infrastructure. Earning a wage is only an intermediate step in improving the quality of life; more important is how the worker can spend their earnings. If people have to travel to a city (or at least a district center) to purchase essential goods, it reduces the attractiveness of rural life and makes it harder to attract and retain specialists. Unfortunately, this is the current situation in the Siberian Federal District's regions. Large rural settlements serve as

centers for household supply stores, providing a wide range of goods for smaller surrounding settlements, where the population has access to only a minimal range of products and virtually no household services. In rural settlements of the Siberian Federal District, minimarkets dominate as the primary type of stores, accounting for 58.3% of the total number of rural stores in Tuva to 90% in the Omsk region [5].

Therefore, to increase the attractiveness of working in organic agriculture, employers have three main options. They can either establish their enterprise in a district center or a large settlement with developed infrastructure, or they can organize transportation for employees from such settlements at the expense of the enterprise, or they can take on additional responsibilities for improving the quality of life of their workers and developing infrastructure.

The challenges of developing the organic agriculture certification infrastructure are largely similar to the challenges of social and domestic infrastructure. Since the demand for this type of service is low, organizations of this profile are unlikely to appear anywhere other than regional centers because the certification process involves laboratory testing and interaction with government authorities. While it is theoretically possible to convert all government procedures into electronic formats and ensure that organic production is staffed with qualified personnel (the current demand for them is not as high as in other industries), equipping laboratory staff would be almost impossible. Therefore, it is most efficient to develop the certification infrastructure based on the following principles:

1. Certification centers for organic production should be government institutions, and their activities should be included in the list of government services provided to the population.
2. Certification should be carried out according to both Russian and various international standards, based on the choice of the requesting producer.
3. It is advisable to have one laboratory complex in the regional center and representation offices in district centers responsible for sample collection and document processing.

Following these principles will allow for the development of the organic product certification system with minimal costs, which will remove one of the main barriers to the industry's development.

If engineering, social, banking, and domestic infrastructure influence the production of organic agricultural products, then transportation is necessary for delivering the produced products to consumers. The financially viable demand for organic products is concentrated in large cities and abroad, i.e., in markets external to the producer [10]. Therefore, to generate profit, it is necessary to deliver goods with the lowest possible costs and losses to the point of sale. In this article, we will limit our discussion to the transportation network of the Siberian Federal District (Table 1).

Table 1. State of Transportation Routes in the Siberian Federal District in 2021.

	Density of railway tracks, km of tracks per 10,000 km^2 of territory	**Density of paved roads, km per 1,000 km^2 of territory**	**Percentage of roads with improved surfaces in the length of public roads, %**
Republic of Altai	0	50	24.37
Republic of Tuva	0	21	18.37
Republic of Khakassia	108	93	36.28
Altai region	93	210	31.77

Krasnoyarsk region	9	12	37.26
Irkutsk region	32	32	29.08
Kemerovo region	175	182	40.34
Novosibirsk region	85	116	32.40
Omsk region	52	100	51.80
Tomsk region	11	25	32.83

In the most promising regions for traditional organic production methods [6], both railways and roads are poorly developed. For example, in the Republics of Altai and Tuva, there is no railway network, and less than a quarter of public roads have improved surfaces. This will inevitably lead to increased wear and tear on vehicles and, consequently, an increase in transportation costs. Moreover, if the products are sensitive to physical damage during transport (such as fresh vegetables or products packaged in glass containers), the likelihood of damage during transportation increases. These regions are recommended to focus on producing goods that target tourists and are not sensitive to transportation or suitable for long-term storage.

In contrast, the Republic of Khakassia has significant potential for delivering organic agricultural products to both the domestic and international markets. Similar conclusions can be drawn for the Altai region, Novosibirsk, and Omsk regions, with the caveat that they predominantly focus on industrial organic product production. However, the Kemerovo region, which has favorable transportation indicators, is known for coal mining, which raises doubts about the environmental safety of its products even when following organic production processes.

The problems of developing rural infrastructure stem from the rural settlement type. As seen in Figures 3 and 4, in the regions of the district, the proportion of settlements with fewer than 3,000 residents is 80-90%, except in the Kemerovo and Tomsk regions, where this figure is lower (66.7% and 78.6%, respectively).

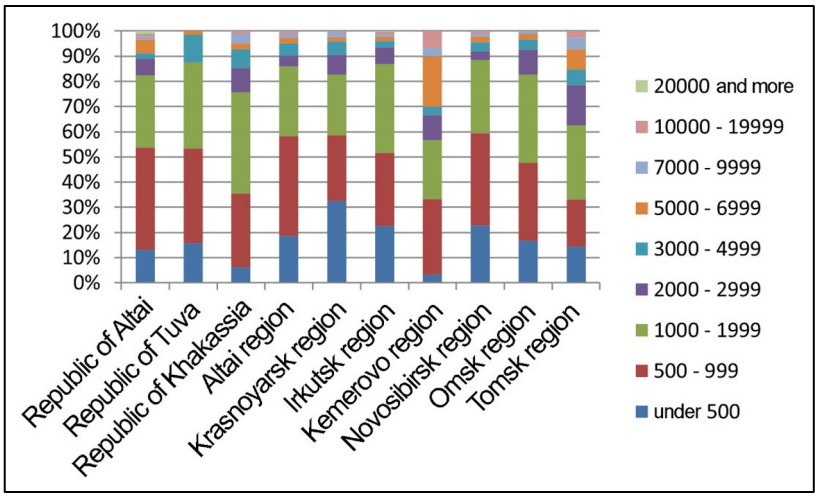

Fig. 3. Grouping of the number of rural settlements by the population residing in them in 2021.

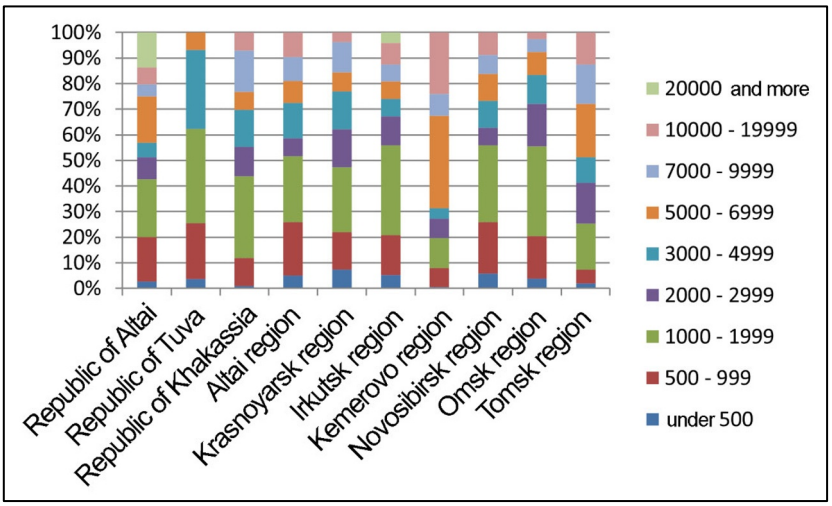

Fig. 4. Population Distribution in Rural Settlements in 2021.

However, more than half of the rural population resides in these settlements in the mentioned regions, except for the Kemerovo region, where the proportion of the population living in settlements with a population of less than 3,000 people is 27.24%, and the Tomsk region (41.2%) [11]. In such small settlements, the continuous operation of most organizations providing goods, labor, and services to the population within a market economy is impractical due to the limited local market, which does not allow for profitability from trading anything other than essential goods. Relatively better off are settlements located near major regional and federal routes, where the lack of local population is compensated by the flow of potential consumers passing through.

In other populated areas, infrastructure development is only possible with active government intervention. This is evident in the fields of healthcare and school education, where the percentage of government institutions in rural areas is close to 100% in all regions of the district.

For the organic agricultural sector, this means that businesses operating in rural areas will either have to adapt to the existing conditions or change them. Let's consider some of the most promising courses of action.

Adaptation can take various forms. First and foremost, entrepreneurs should take into account infrastructure capabilities and constraints at the planning stage of their activities and when selecting the location for their future enterprises. At the local level, this means considering the availability of financial services, road quality and accessibility, the necessary engineering infrastructure, and so on. At the regional and interregional levels, factors like the investment climate, the presence and characteristics of global transportation corridors, differences in natural and climatic conditions, and more.

Next comes the alignment of land, infrastructure, labor, and production technology (we deliberately exclude finances from consideration as they are not the subject of this work). Assuming that land and infrastructure are constant in our assumption, we find that entrepreneurs can vary labor and technology, which are limited on one side by organic standards requirements and, on the other side, by production profitability. Therefore, within these rigid or strictly defined conditions, labor is the variable that can be adjusted.

Firstly, the uneven distribution of certain infrastructure objects can be addressed by unevenly locating employees. For example, if most banks, government agencies, and counterparts are located in large cities, you can keep a special employee in that city authorized to deal with them. Distance work mechanisms can also be used for all employees

whose physical presence at the workplace is not mandatory, such as accountants, HR specialists, and so on. These employees will not change their place of residence when employed, so they will not pay attention to the underdeveloped infrastructure in rural areas.

Secondly, for employees whose presence at the primary place of work is necessary, the organized transportation described above can be applied not only on a daily basis but also on a pendulum schedule, 5/2. On weekends, employees can use their time to meet needs that go beyond what is available at their workplace. This mechanism can be used for both transporting “urban” employees to the countryside and sending "rural" employees to the city.

Thirdly, until a certain point, it is possible to search for unpretentious specialists and train the necessary workforce from local residents. However, these sources are quickly depleted due to higher infrastructure requirements from urban populations and the limited rural labor market. It will be much more effective to work with linked training contracts, where the employer pays for the training of a specialist with the condition that they work for a certain period at their enterprise.

The options for changing infrastructure conditions are not as diverse. Truly effective options can only be the creation or modernization of infrastructure by the enterprise itself or within public-private partnerships [6, 12-14]. Additionally, influencing regional executive authorities during the development of state programs to further develop the types of infrastructure needed by the business can be effective. However, it should be understood that infrastructure projects for organic agriculture entail additional expenses, which will be included in the price of the products and, consequently, reduce their competitiveness [15-17]. Thus, the government gains another mechanism for stimulating infrastructure activity among organic agricultural product producers – increasing their competitiveness through promoting local brands, providing advantages in government procurement, and more.

4 Conclusion

In conclusion, it can be noted that all regions of the Siberian Federal District face challenges related to various types of rural infrastructure and have the potential for organic product production. Overcoming infrastructure limitations and developing the organic industry is possible only through the joint efforts of the government and businesses, with a mandatory consideration of the interests of the population. In the case of success, Siberian producers can be competitive not only in the Russian but also in the global organic product market.

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