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The Development of Agricultural Production Cooperatives in Russia

SVETLANA GOLOVINA,¹ JERKER NILSSON,² AND AXEL WOLZ³

Abstract

After the break-up of the Soviet Union, many collective farms (*kolkhozes* and *sovkhozes*) were transformed into agricultural production cooperatives. Two decades later, most of these production cooperatives are still in operation. Although they face problems as regards wage levels, profitability, and productivity, they are strong in many regions of Russia and within many branches of agriculture. The continued existence of such agricultural production cooperatives puzzles many Western economists. This paper attempts to provide an explanation in terms of the history of Russian cooperatives in the agricultural sector and of the institutional conditions prevailing during the establishment of the current generation of agricultural production cooperatives.

Keywords: Russia, agriculture, production cooperative, kolkhoz, collective farm

- 1 Doctor of Economic Science, Professor of the Chair of Economic Theory, Pro-rector of the Kurgan State Agricultural Academy, Ketovo District, Kurgan Region, Russia (s_golovina@yahoo.com)
- 2 Corresponding author (Jerker.Nilsson@slu.se). Professor of agricultural co-operatives and marketing, Department of Economics, Swedish University of Agricultural Sciences Uppsala, Sweden and Department of Work Science, Business Economics, and Environmental Psychology, Swedish University of Agricultural Sciences, Alnarp, Sweden.
- 3 Research Associate, External Environment for Agriculture and Policy Analysis, IAMO – Leibniz Institute of Agricultural Development in Central and Eastern Europe, Halle (Saale), Germany (wolz@iamo.de)

Introduction

In the former Soviet Union, agricultural production was conducted within large collective farms, some of them organized as “cooperatives” (*kolkhozes*), while others were under direct state ownership (*sovkhoses*) (Domar, 1966). In 1990, on the eve of transition, agricultural production in Russia was carried out by approximately 12,800 *kolkhozes* and 13,000 *sovkhoses*. On average, each of these farms controlled about 7,800 hectares of agricultural land with 320 permanent workers. However, there was also an important household production sector comprising about 14 million rural households that provided a significant proportion of food (Uzun, 2008).

With the collapse of the socialist regimes in Central and Eastern Europe (CEE) and the break-up of the Soviet Union, agricultural economists argued that decollectivization could lead in only one direction, namely a transformation into private family farms, which over time had demonstrated their dominance all over the world (see Schmitt (1993) for a review). In particular, it was argued that the type of organization which would emerge in agricultural production in a competitive environment would be determined by transaction costs, i.e., the costs of acquiring information, monitoring and supervision, and enforcing contracts (Ollila, 1999). Since agricultural production is largely determined by natural conditions and only to a smaller extent by individual efforts, it is not only costly to monitor workers but also difficult to assess the contribution of each worker to the overall performance. So it would be difficult to hand over these tasks to employed workers (Allen and Lueck, 2005). The same reasoning could also be applied in agency theory. The principal (e.g., the owner of a farm) would not trust any agent (e.g., worker), as agents cannot be fully controlled and thus have the option of cheating and free-riding.

In most CEE countries and in Russia, the newly installed governments followed policies that promoted individual farming (Lerman et al., 2004). However, when looking at the organization of agricultural production in these countries today, the outcome is different. In some CEE countries, such as Estonia, Albania, and Romania, all collective farms were dissolved and split up into family farms. In other CEE countries (Hungary, the Czech Republic, Slovakia) and in Russia, however, the farm structure remains polarized as in the Soviet era, with transformed and decollectivized large-scale farms at one end of the farm size spectrum, and family farms, including a multitude of small-scale semi-subsistence farms, at the other (Lerman et al., 2004). Even in East Germany, where family farming was heavily supported after unification, this organizational form has not come to dominate (Wolz et al., 2009).

In Western countries, especially in North America, there has been a trend towards huge agricultural enterprises during recent decades. The concept of “industrialization of agriculture” has become widespread (Boehlje et al., 1995). This development is due to the introduction of new production technologies, which are more efficient. A parallel development has been the introduction of new management tools, such as profit-sharing, outsourcing, and contracting, which make it possible to achieve alignment of the interests of the various participating actors – the financiers, the management, the workers. The large-scale agricultural enterprises in Russia and the CEE countries to some extent use the same technologies and management tools, which help them to become more efficient. However, this does not explain the continuing existence and success of the agricultural production cooperatives in these countries.

During the early 1990s Russia embarked on an agricultural reform process which involved institutional changes that broke sharply with the Soviet past. The reforms were intended to make Russia’s agriculture economically competitive. “In place of collective farms, smaller, specialized farms using family and hired labor were expected to emerge as the backbone of Russian agriculture” (Wegren and O’Brien, 2002, p. 9). However, as in most CEE countries, large-scale landholdings still persisted. While a number of these were later dissolved, many were transformed into newly registered agricultural production cooperatives, limited liability companies, or (closed) joint-stock companies. By the end of the 1990s there were about 22,500 agricultural enterprises, of which about 7,300 were registered as agricultural production cooperatives. Besides agricultural enterprises there were about 260,000 private farmers and about 30 million household plot and garden cultivators (Uzun, 2008; Wandel, 2011). With respect to agricultural production, the shares of agricultural enterprises, household plot farmers, and private farms amounted to 49%, 42%, and 9%, respectively (O’Brien et al., 2011).

This study aims to explore the historical and institutional background behind today’s agricultural production cooperatives in Russia. First, there might be historical reasons why the Russian agricultural sector is largely characterized by collective action. Second, the political and administrative processes after the break-up of the Soviet Union may provide some understanding of why agricultural production cooperatives developed. The study is based mainly on a review of literature and analyses of Russian statistical sources.

The study is structured as follows. The next section describes the early agricultural cooperative movement in Russia, i.e., before the collectivization process. The relative success of the present-day production cooperatives can, at least partly, be explained by historical developments. The following section comprises a discussion about the development of agricultural production cooperatives after the break-up of the Soviet Union, their structure and operations

and main directions of their transformation into other organizational forms. The last section presents some conclusions.

Cooperatives in Russian agriculture – a historical overview

The cooperative movement before 1917

Experiences with human collaboration have been collected over centuries within Russian agriculture. *Obshchina* (village community), *artel*, *skladchina* (pooling of resources for joint purchases), and *vzaimopomoshch'* (mutual aid) are some pre-cooperative forms of collective action (Podgorbunskih and Golovina, 2005). The creation of the first formal cooperative societies was a reaction to the emancipation of serfs and the advent of legally free peasants (1861). The first society was set up in 1866, but was soon followed by hundreds of others (Chayanov, 1991 [1919]; Kotsonis, 1999). Due to the growth of industry, banking, and trade, as well as the expansion of “commodity–money” relations in the villages, rapid development of the cooperative movement took place during the last decade of the 19th century. The development of cooperative societies in Russian agriculture usually accelerated during periods when production was being individualized, i.e., at the end of the 19th and the beginning of the 20th century (Stolypin reform), during the NEP (New Economic Policy) years (the 1920s), and during the latest reforms (from the end of the 1980s).

In 1917, on the eve of the October Revolution, there were 47,787 agricultural cooperatives in Russia, including credit cooperatives (16,055), consumer societies (20,000), agricultural societies and associations (8,132), butter-making *artels* (3,000), and handicraft and other types of *artels* (600) (Table 1). At that time, Russia had the second highest number of cooperatives in the world after Germany.

With the advent of markets and trade, peasants as individuals or as members of associations were in need of access to financial services. As a result, *credit cooperatives* were set up in Russian villages. This cooperative form provided financial aid to rural workers in order to reduce their dependence on private (urban) banks. While such cooperatives were also set up in urban areas, the vast majority operated in rural areas.

Simultaneously, *consumer societies* were established to provide necessities at low prices to villagers. These cooperatives were owned by customers for their mutual benefit. Consumer cooperation was widely adopted in rural Russia during the pre-1917 period. At the end of the Tsarist regime, this type of cooperation was the most popular form in Russia.

Agricultural societies were cooperatives designed to convey knowledge to practicing farmers and their associations. Local leaders formed such organizations

for the purpose of exchanging information and promoting agricultural improvements. Specialist societies in beekeeping, poultry farming, dairying, flax cultivation, and other areas were popular.

Table 1: Development of cooperatives in the Russian Empire at the beginning of the 20th century (number of cooperatives)

Type of cooperative	1901	1914	1917	Growth, 1901-1917 (times)
Credit cooperatives	837	13,839	16,055	19
Consumer societies	600	10,000	20,000	33
Agricultural societies	137	5,300	6,032	44
Agricultural associations	-	1,300	2,100	-
Butter-making <i>artels</i>	51	2,700	3,000	59
Handicraft and other <i>artels</i>	-	520	600	-
Total	1,625	35,875	47,787	29

Source: Tkach (2003), p. 56.

Agricultural associations were cooperatives for different joint operations in agricultural production, such as collective tillage and harvesting, in order to smooth out labor-demand peaks. Membership of such cooperatives permitted villagers to carry out difficult agricultural operations together. In general, they not only provided labor but also agricultural and household equipment.

Already during the latter half of the 19th century, *butter-making artels* were set up. Within a few decades this form of cooperation extended from the European part of Russia to Siberia. As a result, in 1906 Russia was the second largest exporter of butter in the world (after Denmark), while in 1914 Russia's exports of butter made up about 25% of the world market. Besides ensuring a reliable source of farm income, these cooperatives, as well as handicraft and other *artels*, provided additional sources of employment and income to the rural population. Handicraft *artels* promoted the development of traditional crafts and cottage industries in rural areas.

Cooperative development after 1917

The October Revolution in 1917 produced fundamentally different organizational forms in agriculture. At that time Russia was still a rural country, with about 90% of the population associated with agriculture. After the nationalization of all agricultural land, peasants were allocated more than 160 million hectares (about five hectares per family) from the estates of the nobility and large landowners. Nevertheless, farmers had insufficient assets and livestock for successful production. Particularly during the early years after the October Revolution the new government experimented with various forms of joint farming (Schiller, 1969). In 1921 the NEP was proclaimed. It introduced market relations in all spheres of economic life and had a critical impact on cooperative development. One of NEP's purposes was the restoration of the agricultural sector by means of cooperatives. The success of the cooperative movement in the 1920s was a result of the introduction of basic cooperative principles, such as voluntary and open membership, democratic decision-making and control, active participation by members, and a spirit of mutual aid and collaboration.

The cooperative organizations were established in order to implement the new economic policy. Therefore the political leadership took measures to spread cooperation to all parts of the economy. Cooperative enterprises were promoted by financial support from the government and every possible privilege. Permits for free trade, tax concessions, and cheap credit were instrumental for the development of cooperatives. Good trading warehouses, low railway and water tariffs, low rent rates, and preferential access to acquisition of consumer and industrial goods were granted to the cooperative organizations. Due to this support, different forms of cooperatives such as agricultural associations, communes, and *artels* appeared in the villages and their numbers rapidly increased (Table 2). While various types of joint production cooperatives stagnated, service cooperatives of the Raiffeisen model expanded rapidly (Wädekin, 1974).

In the Soviet era the terminology concerning agricultural cooperatives changed to a certain extent. Thus an *agricultural association* was the simplest form of production cooperative, with consolidated land and labor but private property rights to the means of production. The principle of income distribution was connected to labor inputs and family size.

An *agricultural commune* was a form of production cooperative with the joint use of capital, labor, and land. These were created on confiscated land of landlords and monasteries and used egalitarianism as a principle of income distribution – the distribution of income was equal per head. The former agricultural workers became members. The first commune with eleven families was created in the Kostroma region on 280 hectares of land.

An *agricultural artel* represented a specific form of collective establishment with distribution of income according to labor input. The members of *artels* had their own houses and personal household plots of limited size. Gradually, the *artels* became the basic and later the unique form of cooperation in agriculture. The term *agricultural artel* lost its meaning and in relevant legislation the term *collective farm* began to be used instead.

Table 2: Development of agricultural cooperatives and their related associations in the Soviet Union, 1922-1925 (thousands)

Types of cooperatives	1922	1923	1924	1925
Agricultural cooperatives	22.0	31.2	37.9	54.8
agricultural associations	5.0	5.3	4.6	4.6
communes	1.9	1.8	1.5	1.8
<i>artels</i>	8.4	6.8	7.4	8.8
service cooperatives (Raiffeisen-type)	6.7	17.3	24.4	39.6
Regional agricultural unions	1.8	2.4	3.0	9.1
Associations for agricultural production, processing, and marketing	4.7	4.3	4.3	8.6
Multi-purpose agricultural associations	7.0	10.4	17.0	21.9
Total	35.5	48.3	62.2	94.4

Source: Itogi (1927), pp. 419-423.

The most rapid expansion, however, could be observed among the service cooperatives. They had not been promoted during the first years after the October Revolution as they strengthened individual farming, but this changed during the NEP. Their revival, however, was short-lived (Wädekin, 1974).

Finally, three other forms of associations comprised *agricultural production cooperatives at secondary or higher levels*. They were formed according to the location, specialization, or organizational form of their member organizations. In specific terms, *regional agricultural unions* were umbrella organizations for all production cooperatives in a specific region. *Associations of agricultural production, processing, and marketing* operated in joint processing and marketing of agricultural products. *Multi-purpose agricultural associations* evolved on a voluntary basis and included different cooperatives irrespective of location, specialization, and size. All these higher forms of cooperation were established not only to promote agricultural production, but also to lobby for the interests of production cooperatives and their members. By the end of 1926, about 7.8 million peasant farmers had become members of cooperatives.

Towards the end of the 1920s, the curtailment of the NEP and sweeping collectivization radically changed the traditional methods of management and the organizational forms of agricultural production. Collective farms became the basic model in organizing agricultural production. Other forms of organization and cooperation in agriculture were gradually liquidated. Hence, communes, *artels*, and agricultural associations were transformed into collective farms. The supply and marketing functions were transferred to state companies. Instead of a diversity of agricultural cooperatives as recommended by the Russian cooperative pioneer Chayanov, only collective farms (*kolkhozes*) were introduced, and this by the force of law.

Legally, the collectivization of agricultural production was based on two resolutions: “On rates of collectivization and measures of state support to collective-farm building” (1930) and “On rates of further collectivization and problems of strengthening of collective farms” (1931). The share of collectivized production increased rapidly, from 59.3% of agricultural production in 1932, to 92.6% in 1936, and ultimately to 96.6% in 1940. In that year the average collective farm comprised 68 members, 485 hectares of arable land, 72 head of cattle, 28 pigs, and 139 sheep and goats (Minakov, 2007).

During the following decades the collectivization process continued, leading to amalgamation of collective farms. In addition, many collective farms were transformed into state farms. Since the late 1950s, Soviet politics and economic science regarded cooperative forms of agricultural production as a temporary, transitional, and relatively minor phenomenon (Wädekin, 1974). With respect to daily management there was almost no difference between cooperative and state farms. Agricultural production cooperatives, despite their formal statutes, did not practice any of the characteristics or general principles of cooperatives. During the Soviet period, none of the cooperative forms of organization applied democratic principles of management and were managed “top-down”.

Cooperative development before the break-up of the Soviet Union

A new stage in cooperative development began in the second half of the 1980s. The government had recognized the necessity of smaller production systems that could adapt to changes in consumer demand more quickly and more flexibly, satisfy household needs in small-scale production, and offer a wide range of services more effectively. This policy change resulted in the law “On cooperation in the USSR”, passed in 1988.

While the law referred to all sectors of the economy, it had a particular effect on agricultural production. In general, a group of workers (families) on a collective or state farm could form a cooperative and rent land and equipment against promised delivery of a specified quantity of output. Any surplus could then be

disposed of independently (Islam, 2011). By 1990, about 2000 new agricultural production cooperatives had been registered (Table 3). The average cooperative comprised 78 hectares of agricultural land, including 50 hectares of arable land, and had 10 members. Almost all cooperatives had a tractor and a truck, while one in five had a combine harvester. On average, each cooperative farm had 19 head of cattle, more than 30 pigs, and about 40 sheep.

Table 3: Number and size of newly established agricultural production cooperatives in Russia (1 July 1990)

Economic region	Number of production cooperatives	Average size of cooperatives in terms of:					
		agricultural land, ha	arable land, ha	number of members	fixed assets, thousands of rubles	livestock, head	
						cattle	pigs
Northern	107	58	20	10	106.1	12	60
North-western	81	118	67	13	297.6	87	19
Central	279	50	37	9	62.2	18	30
Volgo-Vyatskiy	71	40	34	7	40.7	5	21
Central Chernozem	76	72	60	9	73.0	42	6
Volga	22	104	87	9	55.3	11	25
North Caucasus	533	37	18	11	43.2	5	16
Ural	216	169	123	11	87.0	21	41
West Siberia	282	142	89	12	84.9	30	20
East Siberia	130	103	39	9	64.8	35	23
Far East	229	24	8	10	95.1	16	63
Russian Federation	2026	78	50	10	77.8	19	31

Source: Goskomstat RSFSR (1991).

In general, these newly formed agricultural production cooperatives were closely linked to the collective and state farms. The production cooperatives rented most of their assets from the host enterprises. In 1990 they rented on average 38%

of their tractors, 42% of their combine harvesters, and 64% of their livestock barns. A large number of animals were also leased by these cooperatives: 43% of their cattle, 50% of their dairy cows, over 70% of their sheep, and 26% of their pigs were leased from the host enterprises. In addition, the newly formed cooperatives received inputs and raw materials from the collective and state farms. In return, they sold large quantities of their agricultural products to the host enterprises: 53% of their grain, 43% of their potatoes, 64% of their vegetables, 59% of their meat, and 66% of their milk (Petraneva et al., 2005).

The newly formed agricultural cooperatives adapted to the local conditions by specializing in a variety of agricultural activities, but generally in more labor-intensive activities. Instead of staple grain production they focused on potatoes, vegetables, seed grain, seedlings, flowers, and mushrooms. They also emphasized livestock production, including dairy, cattle fattening, pigs, sheep, and poultry, all of which required substantial labor inputs. The cooperatives developed beekeeping, fur-animal farming, and fish farming. The cooperatives' largest shares in total production were in raising and fattening of cattle (39.6% of national total), potatoes and vegetables (16.6%), and honey and fish production (14.6%) (Petraneva et al., 2005).

The transformation and development of agricultural production cooperatives in the post-Soviet period

The conditions for transformation into cooperatives

After the dissolution of the Soviet Union, Russia enforced a process of restructuring in agriculture. The traditional socialist types of farms had to be restructured, and members were given the option of leaving the collective to start their own private farms. Members could also choose to transform their collective farm into an agricultural production cooperative or agricultural enterprise of some other form, i.e., joint-stock company or limited liability company. The resolution "On the procedure for restructuring of collective and state farms" (29 December 1991) provided the framework for this transformation. In general, restructuring into agricultural production cooperatives was recommended. In this way, it was possible to divide the productive assets among smaller units within a relatively short time. However, it took years before the necessary laws on agricultural cooperatives became effective.

The legal basis for agricultural production cooperatives was laid down in three successive laws: (1) the Civil Code (30 November 1994), (2) the Law "On agricultural cooperation" (15 November 1995), and (3) the Law "On production cooperatives" (10 April 1996). Former collective and state farms could be

transformed into one successor enterprise or into several smaller entities of various legal forms (e.g., agricultural cooperatives, joint-stock or limited liability companies). Some were liquidated and split up into family farms.

We accordingly distinguish two types of agricultural production cooperatives. One type includes cooperatives set up from scratch: these are cooperatives that split off from existing large collective farms or were created by re-agglomeration of family farms. The other type is represented by cooperatives that succeeded the former collective or state farm as one whole. In cooperatives of the first type, the equity was made up of the share capital contributed by the members, who in turn received it during the reorganization of the former collective farm. In cooperatives of the second type, the equity was directly transferred from the former collective or state farm. Cooperatives created by one-to-one transformation of existing collective farms had initial advantages compared with cooperatives created by splitting off. They had an inventory of productive assets from the start, they generally did not change their production orientation, and they continued using the same staff and the established channels for supply of inputs and marketing of products.

One-to-one transformation of an existing collective farm into an agricultural cooperative (or any other corporate form) required an appropriate decision of the general assembly of members and workers. The establishment of a new (usually smaller) cooperative from scratch also required approval by the general assembly of the original enterprise and the land was then transferred to the founding members of the new entity as jointly used and jointly owned property, or as jointly used and individually owned property. Land was transferred free of charge. The average area of land for each member in the former enterprise was calculated through a division of the total land area by the number of members, including non-agricultural employees and pensioners of the enterprise. Additional plots of land were available for purchase by auction. If a newly established cooperative needed a larger area, more land could be obtained by leasing with an option to purchase it later.

Nearly half the total number of agricultural enterprises (i.e., non-family corporate farms) in Russia are agricultural production cooperatives (Table 4; data for 2004). In 2004, agricultural production cooperatives accounted for around 40% of total production of sunflower, sugar beets, milk, and grain (Table 5). Their share of potatoes, vegetables, and livestock was smaller, as these are typically the preferred activities of the small household farms.

Table 4: Number of agricultural production cooperatives in Russia by Federal District (2004)

Federal District (<i>okrug</i>)	Number	% of total	% of the number of agricultural enterprises
Central	3525	28.2	51.6
North-western	775	6.2	43.2
Southern	1725	13.8	37.6
Volga	3837	30.7	55.8
Ural	600	4.8	35.3
Siberia	1437	11.5	38.1
Far East	601	4.8	41.3
Russian Federation	12,500	100	46.1

Source: Minakov (2007).

The relatively large representation of agricultural production cooperatives in Russia may be attributed to the influence of local leaders. Amelina (2000), in a comparative study of decollectivization in Leningrad and Saratov oblasts, stresses the role of regional governments in encouraging or obstructing the development of private farming. It has also been argued that collective farm managers discouraged members from becoming independent farmers. These managers had a strong interest in maintaining the pre-reform status quo, which guaranteed them access to income, local power, and prestige (Allina-Pisano, 2008). Furthermore, agricultural production cooperatives benefitted from their established organizational arrangements and assured political support. As a result, they suffered less from an unfavorable macro-economic environment than the newly created private farmers, who were disadvantaged by poorly functioning markets and limited political support.

Cooperative development within different regions and industries

Looking at their regional distribution, agricultural production cooperatives can be found in all seven federal districts (*okrug*), but they are not spread evenly across the country. The regional distribution of agricultural production cooperatives and their respective proportion of the total number of agricultural enterprises are shown in Table 4 (2004 data, latest available). The largest proportion of agricultural production cooperatives is found in the Volga Federal District (55.8%) and the Central Federal District (51.6%). In the North-western Federal District the proportion is 43.2%, while in the Ural Federal District it is as low as 35.3%.

When looking at the regional level below the level of federal districts (i.e., primarily the *oblast* or provincial level), agricultural production cooperatives constitute the dominant type of agricultural enterprise in some regions. Thus, in the Nenets Autonomous District they account for 88.5% of all agricultural enterprises, in the Bryansk Oblast 80.3%, in the Kirov Oblast 70.8%, in the Tver Oblast 64.0%, and in the Chuvash Republic 68.0% (2004 data; Minakov, 2007).

In terms of their share in agricultural production at the federal district level, agricultural production cooperatives play an important role in the Volga Federal District and the Central Federal District (Table 5). At the level below federal districts, agricultural production cooperatives are the dominant crop producers in some regions. For example, they account for 84.7% of total grain production in the Republic of Kalmykia, 79.5% in Kirov Oblast, and 68.8% in Novgorod Oblast. With respect to sugar beet, agricultural production cooperatives contribute 89.0% of total production in Samara Oblast, 85.6% in Ulyanovsk Oblast, and in 75.4% Tambov Oblast. Concerning sunflower production, they contribute 91.7% in Tula Oblast (2004 data; Minakov, 2007).

The relative contribution of agricultural production cooperatives to livestock production is low in comparison with crop production. However, in each federal district there are regions where they produce a large share of total meat and milk production. For example, their contribution to cattle and poultry production is 80.0% in the Nenets Autonomous District, 66.3% in Kirov Oblast, and 60.3% in Tambov Oblast. Concerning milk production they contribute 96.7% of the total in the Republic of Kalmykia, 73.5% in the Kirov Oblast, and 73.2% in the Tambov Oblast (Minakov, 2007).

Table 5: Share of agricultural production cooperatives in agricultural production in Russia by Federal District, % (2004)

Federal District	Grain	Sugar beet	Sun- flower	Pota- toes	Vege- tables	Livestock , poultry	Milk
Central	47.3	45.1	47.4	29.6	18.8	21.9	44.1
North-western	46.2	-	-	16.1	8.6	14.7	31.4
Southern	28.9	22.9	33.5	27.4	27.5	14.9	27.0
Volga	50.3	57.6	56.8	39.1	16.6	33.0	54.2
Ural	25.6	-	20.5	15.9	28.6	10.4	24.2
Siberia	30.3	46.7	51.7	16.5	13.7	20.2	30.0
Far East	49.3	-	-	21.4	22.9	17.2	30.3
Russian Federation	38.7	42.1	42.2	27.6	20.0	21.9	40.8

Source: Minakov (2007).

Conclusions

Russia's experience with agricultural cooperatives is a unique case. At the end of the Tsarist regime there was already a strong cooperative movement, but during that time and particularly during the Soviet period, agricultural cooperatives were not so much self-help organizations as instruments of government policy.

After the break-up of the Soviet Union, many collective farms (*kolkhozes*) and state farms (*sovkhozes*) were transformed into agricultural production cooperatives. In addition, new agricultural production cooperatives were set up from scratch. After two decades, most of these production cooperatives are still in operation and play a significant role in agricultural production, although this role varies between regions and types of production. Given the prevailing conditions, the development of production cooperatives was a positive experience in Russian agriculture. Nevertheless, it is unclear whether they will be efficient over time.

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