

# Aviation in the agricultural sector: experiments with aviation in the USSR in the 1930-ies

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**Abstract.** The article analyzes the experience of agricultural aviation usage for sowing of grain crops in the Soviet Union in the 1930s. A historiographical review of this problem has been carried out, which testifies to its indisputable scientific, theoretical and applied relevance. The motives for aircraft attracting to sowing operations in the first half of the 1930s have been indicated, and the methods and scale of experiments for conducting aerial sowing have been revealed. By analyzing the scientific literature, archival documents and periodicals of the 1930s, the effectiveness of sowing operations using aviation has been established. The reasons have been revealed, according to which the Party-Soviet leadership eventually abandoned the usage of aircraft as an "air seeder", having focused the air group efforts on the fight against agricultural pests, firefighting, etc.

## 1 Introduction

The mechanization of agriculture developed in the USSR in the 1930s was not limited to the introduction of tractors, combines and other technical means into agricultural production. It was a rather complex process, during which a variety of mechanisms were tested, including those that were not typical for the agricultural sector. One of them was an airplane, which in the 1930s Soviet enthusiasts tried to use as an "aerial seeder". Experiments conducted with the purpose of using aviation during the agricultural crop sowing have become the subject of this article.

The analysis of the scientific literature on the identified problem allows us to confirm that it was covered by specialists in fragments. The most detailed study of such areas of aviation application in agricultural production such as the application of fertilizers for the soil and the control of various pests for agricultural crops by spraying pesticides. In some publications, the facts of the aircraft usage in sowing operations were stated, but the analysis of aerial sowing methods and their effectiveness was not carried out (see, for example: Loginov E. F., Odintzova V. F., Novikov A. A., etc. *Civil Aviation of the USSR. 1917-1967*. Moscow, 1967; *History of civil aviation of the USSR* / Ed. by B. P. Bugaev. M., 1983; Artemjev A. A. *Civil Aviation of Russia. Kemerovo, 2003*; *Civil Aviation of Russia. 80 years: 1923-2003*: M., 2003).

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In the modern scientific literature, interest in the development of civil aviation remains, but the focus of scientists is on such issues as the degree of air contamination and environment with aviation fuel, the development of environmentally friendly fuel, improving the reliability of aircraft, etc. [1-13]

Thus, the problem of aviation sowing in the Soviet Union in the 1930s is quite relevant not only in the scientific and theoretical, but also in the applied plan. The rich experience gained in the 1930s during experiments on aerial sowing and during its practical implementation on relatively large areas can be useful even today, when aviation technology has advanced far in its development, and its technical capabilities have significantly increased.

## **2 Materials and methods**

The empirical basis of this study was the 1930s periodicals and archival materials. Among the most informative periodicals is the newspaper "Socialist Agriculture" - the organ of the People's Commissariat of Agriculture of the USSR, the Collective Farm Center of the USSR, Grain Trust and the People's Commissariat of the RSFSR (Russian Soviet Federal Republic). There various notes and articles have been repeatedly published about the usage of civil aviation in agriculture, including in the field of sowing.

The archival materials, in particular, the document stored in the State Archive of the Rostov region (SA RO) entitled "The use of aircraft in the recent sowing of spring wheat " are of great importance.

It described in detail the course and results of the experiments for aerial sowing conducted in 1933 on the basis of the Soviet farms in the North Caucasus Region, which united the Don, Kuban, Stavropol and the national autonomous regions of the North Caucasus. A thorough analysis of this document allows us to identify the advantages and disadvantages of aerial sowing and to understand why the specialists and the party leadership abandoned it in the end.

The leading methods in the process of the scientific problem solving were historical-genetic, comparative-historical and the method of content analysis. The historical and genetic method helps to trace the process of origin and development of ideas about the forms and methods of aircraft usage in agriculture. The comparative-historical method makes it possible to identify the factors under the influence of which the sowing, which was used in the 1930s with the help of aircraft, was no longer considered as a goal-like and economically justified over the next ten decades. The content analysis method was used to search for semantic units in order to establish the fact of attention and the interest degree of Soviet specialists and government officials to the aerial sowing, as well as the scale of its usage in the 1930s.

## **3 Results**

Planes were used in Soviet agriculture since the 1920s. They were involved in the fight against pests of fields, meadows and forests: locusts, meadow moth, etc. Specially for the performance of these tasks at the People's Commissariat of Agriculture of the USSR, a specialized aviation corps of APC – Association for Pest Control was created (Rukavishnikov B. Aviation method of combating meadow moth // Socialist agriculture. 1931. September 3). Already in 1926 planes from this corps processed 2.3 thousand hectares in order to combat locusts, in 1929 - 30 thousand hectares (Sytin V. The leading method // Socialist Agriculture. 1931. December 5).

However, aviation enthusiasts dreamed of its wider application in agriculture. They wanted to turn the plane not only into a pest control device, but also into a machine that could spray fertilizers and seeds in the fields. It is important to note that the plans about turning of aviation equipment into an "air seeder" arose as a result of the world experience understanding. The aircraft as a means of sowing was used in the 1920s in the United States, which were leaders in innovative developments and the scale of their introduction into production. The Soviet leadership, convinced that socialism in comparison with capitalism had more prospects for the modernization of the national economy, sought to repeat the American experience. However, during the NEP period (New Economic Policy), when the economy was just recovering from the Civil War, there were no opportunities for aerial sowing.

In connection with the deployment of the complete collectivization in agriculture in the USSR, the role of aviation in the agricultural sector has increased dramatically. Already in 1931 more than 26 thousand hectares of cotton were treated by aircraft in order to control pests, and in 1933 the treated areas of various crops amounted to 266.3 thousand hectares or 117.6% of the previous year.

However, according to the plan, it was planned to process more than 1 million hectares, but it was not possible to achieve such indicators for a number of reasons, among which were pilot unpreparedness and lack of pilot experience (Brilliant results of agricultural aviation for six months // Socialist Agriculture. 1933. July 12).

At the same time collectivization led to the fact that the plans for the aerial sowing experienced a rebirth and were able to be implemented in practice. So civil aviation could work on huge land areas of collective farms and especially state farms. Having at their disposal an area of hundreds and thousands of hectares, aerial sowing enthusiasts were finally able to go from words to actions and begin experiments to turn the aircraft into "air seeder".

The first experiments in this direction were conducted in the North Caucasus, which indicated the importance of this region for the country. In the spring of 1931, at the initiative of the North Caucasus Department of APC – Association for Pest Control, an aerial sowing of rice was carried out in the Cherkessk rice farm on an area of 75 hectares, for which the same devices used to spray poisons were used on airplanes. At the same time experiments on aviation rice sowing were conducted in the Slavyansk district of the North Caucasus Region (Zakharov P. Laboratory of Revolutionary daring // Socialist Agriculture. 1931. December 5; Rafes P. M. Air seeder // Socialist Agriculture. 1931. December 5).

Rice was elected for experienced aerial sowing not accidental. This crop was considered suitable, because it is sown not in solid ground, but in heavily moistened soil, in fact in water. When sprayed from an airplane, rice seeds that did not require deep embedding in the ground could easily graft and grow. In addition to rice, since 1931 aircraft had been used for sowing forage grasses (clover, alfalfa, sand oats, mustard) and various plants (cereals, herbs, industrial crops, etc.), which did not require deep embedding in the soil. In particular, in the spring of 1932 an aerial sowing of flax was carried out in a pilot-training flax farm near the city of Torzhok in the north-west of Russia. The sowing was successful and according to experts gave an increase in the yield of 6 % (SA RO, f. r-2573, r. 1, d. 131, p. 42.)

However, in Soviet agriculture grain crops (wheat, barley, rye, oats, etc.) played the leading role. In the case of successful development for their sowing with the help of aircraft, wide prospects opened up for air seeding. So the first experiments of the aviation usage were started in the early 1930s. Unlike rice, cereals required deep embedding in the ground. This fact has not stopped enthusiasts of aerial sowing and they found a way out in very early sowing. In the regions of the North Caucasus Region it began in March and sometimes at the end of February. In this case, the seeds were planted in the muddy mud,

where not only tractors, but even horse-drawn seeders could not work. Therefore, the autumn sowing was carried out manually in collective farms, in a scattered way from a basket as in ancient times. The plane was supposed to be an alternative to manual sowing and gradually replace it.

Experiments on the use of aviation in the sowing of wheat, barley and similar crops started in 1932. Then in the grain farm "Udarnik" in Central Asia, an aerial sowing of wheat was carried out, which gave an increase in yield by 25-40 % (SA RO, f. r-2573, r. 1, d.131, p. 42). In the early spring of 1933, similar actions were repeated in the North Caucasus.

According to the document "The use of aircraft in the recent sowing of spring wheat", the experimental sowing in the North Caucasus Region in the spring of 1933 was carried out by employees of two research institutes: The North Caucasus Research Institute of Grain Farming (NCRIGF) and the North Caucasus branch of the Research Institute of Agricultural and Forest Aviation(NCRIAFA). For the implementation of the experiments by the research team of agronomists was create A. Voronina from (NCRIGF) and S. M. Ogienko from(NCRIAFA), as well as researchers from NCRIGF O. S. Moroshkina and L. V. Pimenova. The base for the aerial sowing was the training and experimental grain farm No. 2 at the station Camel (modern Zernograd). Experienced aerial sowing was also carried out in the Yegorlyk grain farm and "Giant" grain farm (Salsky district).

As a result, the sowing with the help of aviation was carried out on relatively large areas, as evidenced by the data in Table 1 (SA RO, f. r-2573, r. 1, d. 131, p. 89).

**Table 1.** Areas covered by the experimental recent aerial sowing of wheat (in accordance with traditional sowing methods) in the North Caucasus Region in 1933.

FARMS	Seeding size (ha)			
	aerial sowing	scattered sowing with seeders	scattered sowing with hands	Total
The training and experimental grain farm №2	1285	2757	-	4042
Yegorlyk grain farm	1093	-	-	1093
"Giant" grain farm	248	972	-	1220
Collective farm" The Executor of the Five-Year Plan"	-	67,5	67,5	135
Collective farm "The Red Army Man"	-	-	13,0	13,0
Total	2625	3796	80,5	6503

In addition, two collective farms were involved in the experiments – "The Executor of the Five-Year Plan" and "The Red Army Man" (their location is not indicated in the document, obviously, they were located near the listed state farms). In these collective farms, aerial sowing was not carried out, but the usual sowing was carried out with seeders and manually. According to the document, there were no specialists in manual sowing in state farms, so collective farms were involved, where there were "old seeders" who could carry out manual scattered sowing. The involvement of different Soviet and collective farms in the experiments was done in order to conduct a comparative analysis of the obtained results. In accordance with the plans followed, first, to carry out aerial sowing ("sowing in the dirt with a plane"), and secondly, very early sowing ordinary drills "from disk" (and manual sowing) and drill seeding in regular time. It was also necessary to compare the characteristics and results of the sowing produced by the aircraft with other means and methods.

The experiments were preceded by a "special test of the air unit" (the aircraft which, obviously, was the U-2) in February 1933. It was carried out by NCRIIFA at the airfield of the North Caucasus Department of the Agricultural Aviation Trust in the Kuban village of Pashkovskaya. The tests were necessary "to obtain a number of indicators on the technique of aerial sowing", in order to establish the most optimal altitude and flight speed of the "air seeder", etc. During the experiments the objective difficulties of 1933 made themselves felt, due to the fact that according to the results of the poor harvest of 1932, no spring wheat seeds were found for the aircraft. Therefore, "because of spring wheat grain absence with proper conditions, the test was carried out with winter wheat" (SA RO, f. r-2573, r. 1, d. 131, p. 49). However, as it turned out later, this circumstance did not affect the obtained results.

In some cases, the implementation of experiments on aerial sowing was complicated by the cool (and even "very negative") attitude of the local Party-Soviet leadership, the directorate of state farms, the administration of collective farms and representatives of air groups. Thus, there was a "rather strong" delay in the dispatch of aircraft by the North Caucasus Department of the Agricultural Aviation Trust, which ultimately caused the missing sowing dates and incomplete implementation of the plan (SA RO, f. r-2573, r. 1, d. 131, p. 67). However, in most cases the research goals, despite certain difficulties, still managed to be implemented.

During the pilot sowing, the aircraft sowing apparatus was set to sow 58.2 kg of spring wheat per 1 ha "at the rate of half its norm" or 170 pieces of grain per 1 sq. m of land area. The flight speed was 92-107 km per hour, the width of the "wave" (seeded strip) was 11 m. The performance of the air sowing depended not only on the pilot. As the leaders of the experiments noted, "in order to comply with the wave width established by us, and therefore the density and seeding rate, aircraft navigation was carried out according to signals." For this purpose, three signalmen were appointed, equipped with red and white flags and "two-meter" (a design for land area measuring, consisting of three wooden slats in the form of the letter "A", the distance between the "legs of that letter" was 2.13 m). During aerial sowing two signalmen were placed on the edges of the sown area and the third-in the center. After each working flight, the signalmen moved to the side of the unseeded area by 11 meters, i.e., the width of "working wave". So that they did not make mistakes during the transition, did not go further or closer than required, they were given "two-meters" "for more accurate measurement of transitions to the width of the working wave" (SA RO, f. r-2573, r. 1, d.131, p. 53).

Based on the results of the experiments, important conclusions were made that did not cause controversy among the researchers. It was found that the seeding rate is inversely proportional to the speed of the "air seeder", and vice versa. That is, the higher the speed of the aircraft with the accompanying wind, the lower the seeding rate per unit area should be, but if the speed of the aircraft is less or a strong wind hinders the flight, the seeding rate should be increased. In addition, it was found necessary to "design changes to the seeding part of the airplane, allowing the pilot at the time of sowing to adjust the seeding depending on the direction and strength of the wind" (SA RO, f. r-2573, r. 1, d.131, p. 97-98). At the same time, a number of conclusions turned out to be very contradictory and caused discussions among supporters and opponents of aerial sowing.

## 4 Discussion

In general, the experiments showed that the use of aviation allowed to carry out sowing at the earliest possible time and to sow large areas in a minimum of time. In an hour, the plane sowed 15-20 hectares of grain crops, which was ten times higher than the productivity of a tractor, and even more so of a horse-drawn seeder or manual sowing. During the flight day,

the aircraft could sow 150-200 hectares. Thus, in terms of the speed of sowing and the coverage of land areas, it left far behind other technical means and methods. In addition, the grain, thrown early into the ground, did not lack moisture and ripened before the onset of the dry season, in connection with which the yield of grain crops during aerial sowing, according to experts, was 30% higher than the results of scattered and ordinary sowing. In some cases, the quality of aerial sowing was even higher (SA RO, f. r-2573, r. 1, d. 131, p. 88).

During aerial sowing, lower field contamination was also observed: information about this is contained in Table 2 (SA RO, f. r-2573, r. 1, d. 131, p. 85). "If we add to this, "the enthusiasts of" aerial sowing " pointed out, "that aerial sowing is technically possible almost at any time, then its value increases significantly" (SA RO, f. r-2573, r. 1, d.131, p. 88). It was also important that the speed of the aerial sowing (and the very fact of aircraft usage as a seeder) impressed the collective farmers and was an effective means of agitating for the collective farm system.

**Table 2.** Weed infestation of crops with different sowing methods.

Types of sowing	Terms of verification	Total plants per 1sq.meter		
		Cultivated	Weed plants including:	
			Perennial	Young
Aerial sowing	June,14	288	3,5	144,8
Ordinary sowing		433	8,7	209,5
Aerial sowing	June,26	198	9,1	141
Ordinary sowing		192	13,9	135

However, experiments have revealed a lot of shortcomings in aviation usage for the agricultural sector. First of all, the contemporary level of aerial sowing technology is directly dependent on the strength and direction of the wind. For example, if it was carried out in a strong wind, then the grain sprayed from the plane simply flew across the field or fell outside it, which eventually led to large losses of seed material. The disadvantages of the "air seeder" also included uneven spreading and embedding of grain in the soil. It is noteworthy that even an experienced aerial sowing of rice led to the emergence of a significant part of the grains and the lodging of crops, and when sowing wheat, problems arose even more. When in the summer of 1933, South Russian scientists analyzed the results of experiments, it turned out that the depth of the seeds during aerial sowing ranged from 0.2 to 11 cm, and during ordinary sowing, the seeds were buried more evenly, in the range from 0.3 to 8.1 cm. After aerial sowing, the number of wheat stalks per square meter ranged from 163 to 330, indicating a large seed spread. With ordinary scattered sowing, the number of plants per square meter was from 35 to 75, with sowing with seeders - from 45 to 61.

In addition, as it had been already noted, the aircraft needed to use signalers when performing the sowing, indicating the flight lanes to the pilots, which in turn complicated its conduct. Another significant disadvantage of aerial sowing of grain (ear) crops was that the seeds, even sprayed into the mud, still remained close to the ground surface. Therefore, aerial sowing required subsequent harrowing to sprinkle the grains with earth, as well as manual scattered sowing. As the leaders of the experimental aerial sowing stated, the seeds sprayed by the aircraft were sealed with harrows 5-7 days after sowing. The document has not explained why this work was not performed immediately. It can be assumed that it was

not possible to implement the sealing because of the dirt, it was necessary to wait for the soil to dry out. It is also important to note that the use of harrows was hampered by the presence of weeds and crop residues in the fields, which were stuffed on the teeth, and the workers assigned to the units "with great difficulty coped with the duty assigned to them." As a result, some of the grain remained on the surface even after harrowing in two tracks (SA RO, f. r-2573, r. 1, d. 131, p. 70-71).

## 5 Conclusions

Despite the obvious drawbacks of aerial sowing, initially it attracted many supporters among experts and the party leadership. They were impressed by the very idea of revolutionary changes in the traditional means of agricultural crop sowing. For the first half of 1933 with the help of aircraft in the major regions of the USSR around of 68.2 hectares (62 thousand hectares of 90.9 % of crops) was held, which is 3 times higher than in 1932. At the same time, sown of 68.2 hectares to 40 hectares was carried out very early sowing. The experience accumulated by the pilots led to the fact that, according to the press, in the first half of 1933, the cost of one flight hour decreased by 32 % while reducing the accident rate by 4.2 times (Brilliant results of agricultural aviation for six months // Socialist Agriculture. 1933. July 12). In 1934, aviation continued to be used in the early sowing of grain crops (Chilim I., Astafyev N. Winged sowers // Hammer. 1934. March 29). Thus, according to the reports of the district land department of Starominskaya district of the Azov-Black Sea Region, established in January 1934 and uniting the Don and Kuban for the first half of March 1934, 1 906 hectares of ear crops were sown by aircraft (SA RO, f. r-1390, op. 7, d. 677, p. 177).

Finally, the advantages of aerial sowing were more modest than its disadvantages. By the end of the 1930s, experiments to turn an airplane into an "aerial seeder" had virtually stopped. It is significant that in the article by A. Weissman published at the beginning of 1941, which listed in detail the main areas of aviation application, was not even mentioned about aerial sowing (Weissman A. Agricultural aviation // Socialist Agriculture. 1941. No. 2. p. 77-79)., there were attempts to revive aerial sowing after the Great Patriotic War, but they all ended in the same way as in the 1930s. One of the Soviet journalists quite accurately outlined the reasons for the collapse of such experiments after 1945. He pointed out that "the very idea of aviation usage in sowing is harmful", since it is, in fact, the same scattered sowing, only not from a basket, but from an airplane (Ostapenko G. In the Ust-Labinsky district sowing is slow, agricultural machinery is violated // Soviet Kuban. 1950. March 4).

Thus, it can be noted that during the period of collectivization in the Soviet Union, attempts were made to introduce such an alternative to the tractor as an airplane into agricultural production. Soviet scientists and enthusiasts tried to use aviation for sowing agricultural crops. The experiments have shown that after the necessary technical improvements and improvements, the airplanes can be used for sowing crops sown in water or shallow in the ground (rice, clover), as well as for early sowing of grain crops (wheat, barley, rye, oats). However, in the conditions of the 1930s. the practical disadvantages of the aircraft as an "air seeder" turned out to be more significant than its technical capabilities. For this reason, aerial sowing did not acquire a wide scale, and it was decided to abandon the further use of aviation in the agricultural sector.

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