Methods of growing high grain yields in Northern Kazakhstan during the years of virgin lands development (the case of the Zarechny state farm)

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Abstract. This article examines the development of virgin and fallow lands in Kazakhstan in the 1950s. Since the climate in the Kazakh steppes was sharply continental, arid, and the soils unsuitable for farming, the cultivation of grain crops was associated with huge risks and difficulties. Everywhere in those years a great number of state farms were established in Kazakhstan, which had to develop not only vast areas in extraordinary conditions and terms, but also apply innovative for that time and for that area methods of cultivation of high yields of grain crops. Analysis of the materials showed that, despite the difficult natural and climatic conditions, lack of agricultural machinery and labour, the virgin lands cultivators harvested high yields by applying the method of layer-by-layer tillage. The authors concluded that in the course of land use state farm specialists tried to maintain the quality characteristics of the soil.

1. Introduction

The development of farming and land relations in Kazakh society has always attracted the attention of the scientific community [1]. The middle of the last century had a positive impact on the economy and social structure of the Kazakh region, had significant positive results, primarily related to the agricultural sector of the economy [2–13]. One of the brightest projects in this direction was the development of virgin and fallow lands in Kazakhstan in the 1950s – 1960s [14]. It was during these years that the land of Kazakhstan became one of the world centres for the production of high-quality durum wheat. Everywhere in the territory of Northern Kazakhstan began a massive ploughing of land, allotted for sowing grain crops. Thus, if we compare the area under crops in the Union republics, we can note that by 1956 they had changed in all categories of farms in the following way. See table 1 (in million hectares) [15].

As can be seen from the table, over 3 years, the sown areas in the Kazakh SSR increased by 18 million hectares, or almost 3 times, in the Ukrainian SSR by 1.5 million hectares, while in the Latvian, Estonian, Moldavian and Georgian republics they decreased. Undoubtedly, the massive ploughing of land in Kazakhstan is associated with the presence of a huge array of pasture land, which was allocated for sowing grain crops [16]. One of the administrative districts in which mass ploughing of

land took place under emergency conditions was the Zarechny state farm. In a short time, it was able to develop and put into practice innovative methods of growing grain at that time. In this paper, we will dwell on the characteristics of the practical methods of work of this state farm, the experience of which was later used by other grain collectives.

Table 1. Crop area under cultivation.

Republic	1953	1954	1955	1956	1956 by 1953	In % by 1955
Ukrainian SSR	31.0	31.6	32.9	32.5	105	99
Byelorussian SSR	5.13	5.33	5.45	5.55	108	102
Uzbek SSR	2.81	2.91	2.96	3.00	107	101
Kazakh SSR	9.7	11.5	20.6	27.9	286	135
Georgian SSR	1.03	0.94	0.95	0.91	88	96
Azerbaijan SSR	1.11	1.13	1.27	1.24	112	97
Lithuanian SSR	2.19	2.24	2.05	2.26	103	110
Moldavian SSR	1.94	1.90	1.98	1.91	98	96
Latvian SSR	1.60	1.62	1.45	1.45	91	100
Kirghiz SSR	1.08	1.14	1.21	1.22	113	101
Tajik SSR	0.77	0.80	0.81	0.78	101	96
Estonian SSR	0.89	0.85	0.78	0.77	87	99

The Zarechny state farm was organized and began to carry out economic activities on January 1, 1955. The land fund of the state farm at that time was about 29,000 hectares, located in the Northwestern part of the Yesilsky district of the Akmola region. The borders of the state farm coincided with the regional borders in the southwest with the Molodyozhny state farm for 16 km long, and in the Northeast direction with the Tselinny, Druzhba and Priishimsky state farms – for over 50 km. In the Southeast direction, the land use of the state farm bordered on the Ishim River with the neighbouring Kalachevsky and Dalniy state farms of the Yesil district of the Akmola region.

2. Materials and methods

This article is an interdisciplinary study, as the methods of various disciplines, i.e., ecology, agronomy and history – were used in the study. In addition to the interdisciplinary approach, scientific and theoretical approaches developed by domestic and foreign researchers were used to study diverse sources for the period under study. Among them, the methods of critical selection, systematisation and verification of written sources on the history of the virgin campaign in northern Kazakhstan in the 1950s should be emphasised.

3. Results and Discussion

Climate.

Before dwelling on the methods of growing high yields on the Zarechny state farm, we will give a description of the soil and climatic zone that became the site of the massive development of the virgin land.

On the plain treeless steppe expanses of Northern Kazakhstan (Akmola, Kokchetav and Kustanai regions) there have been no separate micro-zones according to soil differences and climatic features and phenomena. The climate is continental, i.e. quick change during the day and even one day of high positive temperature up to 7 degrees below zero with precipitation in the form of rain and snow. A windless warm sunny morning, sometimes within two or three hours, is replaced by a stormy cold wind, accompanied by rain or sleet and icy roads. The local climate is characterized by: aridity, especially in the spring-summer period; high summer and low winter temperatures, with constantly blowing strong winds; the annual amount of precipitation fluctuates in dry years by 180–200 mm, and in more humid years, precipitation reaches 350–380 mm. Winter is long and severe. Freezing of the soil occurs from the first to the tenth of November.

Summer is the shortest, but hot, especially in June and in the first half of August. The vegetation experiences a great lack of moisture, especially at the beginning of the growing season. The duration of the frost-free period in some years ranged from 100 to 120 days. The last spring frosts occur in June, and early autumn frosts came at the end of August. The vegetation period does not exceed 160 days [17].

Soils.

The surface of the soil at increasing low temperatures and the absence of snow cover is covered with continuous cracks, through which a lot of soil moisture is lost. Snow cover, which allows to start snow retention, comes no earlier than the second half of December. The height of the snow cover is 20–40 cm, and in some years on equal fields of autumn ploughing and on snow stubble, the snow cover did not exceed 2–10 cm. Spring is short but cold. The beginning of spring is in mid-April, the end is in the last days of May, and in some years, spring came unusually early – the first of April. It has been possible that, with increasing temperatures in the plus zone and no rain, field work could be completed not only to prepare the soil but also to complete sowing of all the early spike crops by 1 May.

The main land use of the state farm is located on a flat watershed plateau with slightly sloping slopes and a general slope of the terrain to the south-east towards the Ishim River. The soil cover of the Ishim River is represented mainly by dark chestnut soils richer in humus than the southern chernozems. The soil survey identified the following eight soil varieties: dark chestnut carbonate; dark chestnut carbonate solonetzic; meadow-chestnut carbonate; dark chestnut carbonate washed away and others.

Characteristic features of the chestnut type are pronounced conditions of aerobiosis. Under these conditions, the decomposition of organic residues and humus occurs faster, which is the reason for the insignificant content of humus in soils and the rapid loss of strength of the soil structure. The land area of the state farm – 54320 hectares, incl. cultivated arable land – 42500 ha, natural pastures on stony hills – 10000 ha, under estates, roads, water and other inconveniences – 1820 ha.

Grain Growing Methods.

In 1955, by the beginning of field work, from neighbouring MTS and according to orders from industry the state farm received 57 DT-54 tractors and 2 S-80 tractors, which ensured the developing of virgin soil on an area of 27,300 hectares. From the first day of work on the development of virgin lands, the specialists of the state farm paid special attention to the observance of the elementary rules of agricultural technology with the high quality of the work performed. Ploughing of virgin soil was carried out with P-5-35 ploughs and only with skimmers to a depth of at least 25 cm without a single case of flaws and ridged ploughing along the passes of each circle. In other words, in the first year of operation, possible instances of fraud were ruled out. This measure allowed the layer of ploughed fallow land to be well cut, with a single-track disc harrow set to work at 35 degrees of disc attack and reliable ballast, in particular, up to 100kg of coarse metal being placed in each ballast box [14].

Spring tillage consisted solely of harrowing the soil with heavy harrows. The first harrowing is the closing of soil moisture in the ploughing cross section, lasting three days. Repeated harrowing was carried out from the beginning of soil ripening along the length of the ploughing pass, which corresponded to 4–5 days from the beginning of moisture closure. This was followed by sowing with 4 seed drills on prepared land and only in the cross-ploughing direction. The pre-sowing longitudinal harrowing carried out gives good visibility to the tractor driver when sowing transversely at any time of the day or night, which was the basis for all further work of the seeding units of this state farm.

The specialists of the state farm have always paid special attention to the preparation of seeds for spring sowing. In winter, the seed grain was carefully sorted in seed cleaning machines. In control and seed laboratories and directly at the state farm, the seeds were checked for moisture, similarity, purity and economic suitability at least 3–4 times. Before sowing, the seed grains were thoroughly dressed with Granozan at a dosage of 1 kg per tonne of seed. During the period of seed transportation to sowing units, seeds especially of wheat were sprayed with 12% hexachlorane dosage of 10 kg per 1 ton of seeds as a deterrent against wireworm larvae, false wireworms and possible occurrence of

wintering stock of grey Akmola grain moth caterpillars. At the same time, the seeds were enriched with phosphorus-bacterin by spraying with a solution at the prescribed dosage per hectare-portion, which increased the yield from 80 to 120 kg of grain per hectare [17].

The seeding rate and the depth of seed placement for each unit on the first day of sowing were set by the agronomists of the departments together with the foremen, which was subsequently systematically controlled. The main measure in determining the depth of the coulters was the placement of the springs on the boom on the third or fourth hole from the bottom. Further deepening of the coulters of the seed drills was achieved by adjusting the screw on the fork of the deepening wheel. Agronomists allowed a gap between the heel of the fork and the roller on the fork with a screw of no more than one and a half centimetres. With this position, the depth of penetration of the seeding discs on loose and ripe soil reached from 7 to 9 cm, which guaranteed the planting of grain in the moist soil layer and obtaining even shoots of all sown seeds.

Harvesting in 1956 was carried out by the state farm mainly by direct combining. As a result of harvesting from an area of 25,800 hectares, 42,880 tons of grain, mainly wheat, were harvested. The average yield is 16.5 centners per hectare. Of the harvested crop, 37,500 tons of Kazakh wheat were handed over to the state; as a result of economic activity, the state farm had 9.3 million profits. Such a harvest for 1956 was far from the limit, since in the same year the collectives of the third and fifth brigades of the state farm ensured that each hectare received 21–22 centners of wheat. It was one of the best harvesting results in northern Kazakhstan [18].

Positive factors of layer-by-layer tillage should be noted. Firstly, a deeply ploughed layer of virgin soil on its surface had a centuries-old accumulation of humus from the decomposition of plant residues, as well as a significant supply of crumbled seeds of various annual and perennial plants, regardless of whether they grew in this place or were carried by the wind, mixed themselves like seeds wild oats or perhaps accidentally delivered by migratory birds, or by wild animals and rodents, seeds sticking to wool, dirty feet, or lost food. In this position, the seeds of all plants that fell to the bottom of the furrow with a depth of 25–27 cm and were tightly covered with wrapped soft earth or a layer, certainly being in a wet state, should have shown vital activity. But from such a depth, agronomic practice did not record cases of the emergence of shoots of annual and perennial plants, and if the accidental emergence of shoots of weeds took place especially in fields allotted for pure fallows, then such weeds were destroyed by surface treatment. Secondly, the layered system of the main tillage had a great advantage over the usually used template system of the main tillage on soft, old-arable, heavily vegetated and weedy lands (and there were the majority of such lands), since the unsystematic, template-applied and hastily, mainly in the spring, surface tillage with disc cultivators led to severe clogging of the soil with thistle, milkweed, and especially wild oat, as well as partial dispersal and loss of soil structure [19].

Thirdly, an increase in the arable soil horizon to 27–30 cm significantly improved soil porosity, increased water regime and soil moisture, improved soil aeration and aerobic processes, several times increased the number and vital activity of microorganisms, which are the main source of decomposition and mineralization of introduced organic fertilizers and irrigation residues. A sufficient supply of mineral substances and soil moisture in the soil provided such a culture of agriculture not only to maintain soil fertility, but also to significantly increase the yield of fields [20–21].

In 1956, for the first time, the task was set to carry out harvesting in a separate way over the entire area of 35,655 hectares of grain, which at that time was greatly complicated by the lack of reapers. The cutting of all the crops was done mainly by trailed combine harvesters, which were again converted to picking up the crops after the grass had been cut. This double work of combines was reflected in the delayed harvesting and heavy wear and tear on the combines. However, the Zarechny state farm coped with the difficulties. All the grain was cut in 12 working days, but this led to a big gap between mowing and threshing. The continuous rains that began on September 10, which repeated every year, not only delayed the threshing and delivery of grain to the state, but also led to large biological and mechanical losses of grain. If before the rains the nature of the grain was 810 gr. in one litter of grain, then by the end of harvesting it decreased to 730 gr., which was 10% of biological

losses on the specific gravity of the grain. The swaths were poorly picked up by the rain, which also resulted in significant losses [22].

The total loss of grain during harvesting was determined up to approximately 3 centners per hectare and is associated with the extension of the harvesting period, the poor quality of harvesting, and the unsatisfactory organization of harvesting. At the Zarechny state farm, grain losses were primarily due to an insufficient number of reapers. As a result of grain harvesting on an area of 35,355 hectares, an average yield per hectare was 14.5 centners, and the total gross harvest amounted to 53,310 tons, of which 45,080 tons were handed over to the state in test weight.

Despite the difficulties, the state farm showed good harvesting performance. So, as a result of economic activity, the state farm had 5.3 million roubles of profit. The delay in harvesting and rainy autumn weather did not allow the state farm to carry out in the fall of 1958 the main soil preparation for sowing spring crops in 1959. Therefore, the sowing of spring crops in 1959 was placed for the first time mainly for spring soil preparation. See table 2 [17].

Table 2. Sowing of spring crops.

No	Sown	Hectares	%
1	On fallow	1400	4
2	On threshing land	4800	14
3	By spring ploughing	6330	18.4
4	Spring disc cultivators	21832	63.6
5	Total sowing	34362	100

Consequently, 28,162 ha, or 80% of the total spring sowing area of 34,362 ha, were sown only for the spring main tillage. A huge role in increasing productivity was occupied by an increase in the culture of agriculture and a properly selected and scientifically based system of basic tillage.

At the Zarechny state farm, a layered system of basic tillage was introduced and used. Thus, in agronomic and practical terms, the fallow field played the role of clearing the field of weeds, sufficient accumulation of nutrients and restoration of soil structure. For several years at the state farm there was a surface treatment of fallow fields with disc cultivators in the longitudinal and transverse directions. The cultivators in working condition had a 35-degree angle of attack of the discs. The frame of the cultivators had a good ballast weight, which contributed to the maximum deepening of the disks. Usually, after the second pass of the cultivators across the previous work, the depth of surface treatment reached 10–12 cm. After such treatment, the field remained in a clean state for at least three weeks. Subsequently, with the first appearance of weeds (which usually corresponded to June 25), on July 5, the brigades began ploughing the field with ploughs with skimmers and a trailer of two rams of hogs behind the ploughs. Ploughed fallows were carried out to a depth of 25–27 cm. In such a fallow field, in the most humid years and in heavily weedy areas, it was required to carry out no more than 1–2 surface treatments: the first treatment with cultivators, the second with disc cultivators.

In the following after harvesting, on such processing of a fallow field at the state farm, only surface processing was used with disk cultivators of the longitudinal and transverse directions. In the third year, this field was ploughed into ploughing at a depth of 23–25 cm. And, finally, in the 4th year, the main cultivation under the conditions of the state farm was carried out with disc cultivators, which ended the rotation of the four-field crop rotation. In the five-field and six-field crop rotations, autumn ploughing was carried out to a depth of 20–22 cm. The next rotation of this fallow field began first with surface disc ploughing and then ploughing with ploughs with skimmers to a depth of 25–27 cm. Subject to the above-described layer-by-layer basic tillage, the fields of the state farm on the main land mass were in a clean state from weeds for a long time.

It has been indicated above that in 1959 the state farm sowed spring crops mainly by spring tillage: out of 34,362 ha of spring crops, only 6,200 ha or 18% were sown on fallow and threshing land, the remaining area of 28,162 ha or 82% was sown by spring ploughing and spring disc hulling, which was

a characteristic analysis of the results of obtaining yields on the virgin soil layer, autumn ploughing, spring disc hulling and spring ploughing. See table 3 [17].

Table 3. Characteristic years by humidity and weather conditions.

Years	Spring crops sowing	Area		From the harvest from 1 hectare, centner	Gross harvest in tons
		Hectares	%		
1956		25860	100	16.5	42830
1957		26070	100	1.6	4044
1958		35355	100	14.5	52744
	on fallow land	1400	4	21.0	2940
	on threshing land	4800	14	18.0	8640
1959	by spring ploughing	6330	18.4	14.5	9220
	by spring disc cultivators	21832	63.6	16.2	35842
	Total	34362	100	16.9	56642
	on fallow land	3030	10.7	12.5	3660
	on threshing land	3010	9.1	11.0	3520
1960	by spring ploughing	3600	11.1	10.2	3670
	by spring disc cultivators	23890	69.1	11.1	26803
	Total	33800	100	12.2	37653

Thus, the surface treatment of fallow fields with disc cultivators in the longitudinal and transverse directions made it possible to increase grain yields at the Zarechny state farm.

4. Conclusion

Thus, the Zarechny state farm was one of the first in the history of development of virgin lands in Kazakhstan to use layer-by-layer system of main soil cultivation. The fallow field allowed to accumulate minerals in the soil and played the role of clearing the field from weeds. Soil cultivation with disc harrows in longitudinal and cross direction has improved soil porosity, increased water regime and reserve of soil moisture, that in aggregate undoubtedly influenced to cultivation of high yields of grain crops in northern Kazakhstan.

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