Dynamics of Agrarian Lands of the Republic of Tyva (Russia) in 1890–2019

A. Sambuu, D. Dabiev
Tuvinian Institute for the exploration of natural resources of the Siberian branch of the Russian Academy of Sciences, Kyzyl, Russia
E-mail: Sambuuan@Sambuuan.yaconnect.com

Abstract. The article is devoted to the analysis of changes of croplands dynamics of the Republic of Tyva during traditional, Soviet, crisis and post-crisis periods. It is shown that despite the fact that the leading branch of agriculture of the Tyva People's Republic (TPR) was animal husbandry, crop production developed no less dynamically, and crop area in 1944 increased by 4.3 times over 17 years. During the period of the Tuva Autonomous region (TAR), crop area increased significantly, so in comparison with 1945, by 1960, the area of grain crops increased more than three times, amounting to 279.8 thousand hectares, including wheat – 193.6 thousand ha, barley – 21.7 thousand ha, oats – 34.7 thousand has, millet – 27.1 thousand ha. The crop area of the feeding grounds has increased by an order of magnitude. The acreage of vegetable and melon crops, including potatoes, has significantly increased. But the unjustified plowing of virgin and fallow lands in the 50s and 60s of the twentieth century led to soil erosion and destruction, and the loss of more than a million hectares of agricultural land. During the period of the Tuva ASSR, there is a further increase in crop area. The largest area of grain crops was observed in 1980, when there were 370 thousand hectares in the Republic. At the same time, the Central zone accounts for about 2/3 of the crop area of grain crops, the Western zone – 20%, the Southern zone – 5%, and the Eastern zone – only 1%. With the beginning of market reforms, there is a decrease in the crop area of grain crops. Lack of state support, violation of economic relations, price disparity, lack of tax incentives and preferential loans, and other market and non-market reasons led to the ruin of large farms in the Agro-Industrial Complex (AIC), which accounted for more than 99% of agricultural products. The crop area of grain crops in 2000 compared to 1980 decreased by 8.4 times, wheat by 6.7 times, and fodder crops by 11 times. At present, there is again a slight increase in croplands.

1. Introduction
The steppe region of Central Asia has supported human culture for thousands of years and during this period has been subject to major climatic and social changes. In the past, this area was sparsely populated and the land fully provided for the needs of the local population, leading a nomadic lifestyle. Folk customs strictly regulated the nature, timing, cycles and duration of land use. Also, due to repeated rest periods, the condition of the land was good [1].

The steppes of the Asian part of Russia are a significant agricultural region, but little attention is paid to it in the literature. Therefore, research on the problems of rational use of agricultural land in Tuva,
analysis of changes in the structure of arable land and agricultural land in the arid zone of risk agriculture is particularly relevant.

The Republic of Tyva is the youngest subject of the Russian Federation, which became part of the country in 1944. It is part of the Siberian Federal district, in the South and South-East it borders with the Mongolia, in the North-East – Irkutsk region, in the North-West – the Republic of Khakassia, in the East – the Republic of Buryatia, in the West – the Republic of Altai, in the North – Krasnoyarsk region. Total area of the region is 168.6 thousand km². The Ubsunur basin in the southern part of Tuva belongs to the Basin of Large lakes of Mongolia.

For thousands of years, land use in Tuva has been conditioned by the unique natural and climatic conditions and the development of pasture-based animal husbandry. At present, animal husbandry is the main traditional sector of the Republic's economy. Agriculture, along with animal husbandry, has been a vital branch of Tuva's agriculture since time immemorial. It is very surprising that in ancient times the size of the acreage on the territory of the Republic was not inferior to modern ones. In the last century, political and economic changes in Russia, in the republics of Tuva, Khakassia and Buryatia caused changes in the population density of the regions, in the ways of organizing the economy and the state of the land. Unfortunately, today the size of Tuva's croplands is even lower than the level reached by the Tyva People's Republic (TPR). In our study, we will try to consider the dynamics and structure of the acreage of agricultural land in the Republic in different historical periods, and the socio-economic reasons that influenced these changes [2].

The purpose of the study is to identify the ecological and economic reasons for changes in the croplands of agricultural crops on the territory of Tuva for the period 1890 to 2019.

2. Materials and methods
The objects of research are agricultural lands in the intermountain basins of Tuva.

Tuva is located in the Central part of Asia between 50–56° N. l. and 89–99° E. l. From an orographic point of view, the Tuva landscape region of the Altai-Sayan mountain country has clearly defined borders that separate the mountainous part from the low mountains and foothill depressions [3]. A characteristic feature of the terrain is the presence of high ridges and highlands located on its outskirts and intermountain basins [4]. In General, mountain systems cover more than 80% of the entire territory of Tuva, and about 20% comes from intermountain basins: dry-steppe Central Tuva, consisting of the Kyzyl, Ulug-Khem and Khemchik depressions; steppe Turan-Uyuk; taiga-forest Todzha and Tere-Khol; semi-desert Ubsunur. The complex terrain of the Republic has a strong influence on the regime of meteorological elements and, especially, on the surface temperature.

According to the climate essay by N.A. Efimtsev [5], Tuva reflects the influence of neighboring territories: from the North and North-East – taiga Eastern Siberia, from the South and South-East – desert-steppe regions of Mongolia, from the West – mountain-taiga Altai. Due to this geographical location and the sharp division of the terrain, the natural features of Tuva, including the climate, differ in significant contrast. According to E.M. Murzaev [6] the Northern border of the deserts of Central Asia passes here.

Low-snow winters, hot and dry summers, low precipitation and high amplification of absolute and daily temperatures are characteristic features of the Tuva climate. Thus, the average temperature of January under the influence of the Siberian anticyclone in the basins is minus 28–35°C, July – 15–20°C, the average annual temperature is from -3.3 to -6.1°C, the height of snow cover is 10–20 cm. The amplitude of extreme values of air temperature for a year is 82–90°, the amplitude of extreme values of temperature on the soil surface is 118°. The sum of temperatures above +10°C is 1812–2086°. On average, the frost-free period lasts about 185 days (from April 15 to October 18). The period of active vegetation with daily temperatures not lower than 10°C lasts on average 134 days (from may 8 to September 19). During this period, the sum of active temperatures with 80% security is 1864°. The cold period lasts 205–225 days, 50–80% of these days are windless. Moisture in the basins is poor (Hydrothermal
coefficient – 0.4), there is an average of 200–300 mm of precipitation per year, in the mountains – 700 mm [7, 8].

Agricultural land is occupied by intermountain steppe basins with heights of 550–1200 m above sea level, the lower parts of mountain slopes, and high terraces of river valleys. Large tracts of the steppes are characteristic of the Central Tuva and Ubsunur basins.

To analyze the structure and dynamics of croplands and farmlands in the administrative areas of the Republic of Tyva (RT) was involved literary, stock and statistical materials, gathered in the Federal service of state statistics [9], Federal service for state registration, cadaster and cartography for the Krasnoyarsk region, the Republic of Khakassia and the Republic of Tyva [10], the Ministry of natural resources and ecology of the Republic of Tyva [11–13].

3. Results and discussion
At the beginning of the bronze age, the tribes of southern Siberia made the first steps in the development of cattle breeding. Tuva was dominated by a settled pastoral and agricultural forms of economy. In the middle of the first Millennium BC, cattle breeding became the main occupation of the population of the steppe regions of Tuva, and caused the transition from a settled pastoral-agricultural life to a seminomadic one. A large number of livestock could be kept on the significantly expanded pasture areas. Increasing pasture load required seasonal migrations [14].

Typical features and features of the Tuvans' farming in the pre-Soviet period were traditional nomadic cattle breeding, which was maximally adapted to the local natural conditions. Along with animal husbandry, Tuvans also engaged in agriculture, which was a subsidiary occupation. Thus, since 1890, small areas (about 3 thousand hectares) of irrigated arable land were created in the river valleys of the Yenisei and Khemchik. No more than 25% of peasant (in Tuvan «Arat») farms located mainly in the Ulugh-Khem and Khemchik depressions were engaged in agriculture. The cultivation of crops was very primitive and at the beginning of the XX century only 3.5 thousand ha of land were sown (Fig. 1). In the spring, the Arats watered, loosened the land with a wooden plough, scattered the seeds and then closed them up with scrapers of the shrub Caragana [15].

Figure 1. Dynamics of acreage areas of TPR in 1890–1944, thousand ha.
**The period of the Tyva People's Republic (1921–1944).** The Leading branch of agriculture was also animal husbandry of the TPR. The number of livestock in the period of the TPR increased significantly and according to the data of 1945 was 759 thousand heads, including 542 thousand heads of sheep and goats, 129.8 thousand heads of cattle, 61.7 thousand heads of horses, 25 thousand heads of other animals (yaks, camels, deer, pigs) [16].

However, crop production developed no less dynamically, and acreage areas also increased. In comparison with 1927, acreage areas increased by 4.3 times and amounted to 58.1 thousand ha.

Unfortunately, the history of TPR agriculture has not yet been sufficiently studied, and specific data on acreage areas for the structure of agricultural crops of this period are not yet available.

But according to the Tuva agricultural and demographic census conducted by Soviet scientists, crop area of grain in 1931 was 19.4 thousand ha, including wheat 7.5 thousand ha, barley 3 thousand ha, oats – 4.5 thousand ha, millet – 3.7 thousand ha. The area of vegetable and melon crops was insignificant and amounted to only 0.2 thousand ha, including potatoes 0.05 thousand ha, forage crops – 0.02 thousand ha [17, 18].

**The period of the Tuva Autonomous region (1944–1961).** After the TPR became part of the Soviet Union in 1944, agriculture received a new impetus for its development. On the one hand, the nomadic population of the Republic was transferred to a settled life, which was carried out simultaneously with the collectivization of agriculture – personal farms were replaced by collective and state farms. These moments had both positive and negative sides. On the other hand, new cities and towns were built, and new branches of the national economy were developed.

Significant investments were made in both industry and agriculture. Widespread use of mechanization in agriculture, with the creation of machine and tractor stations, has significantly increased the plowing of area under crops. Grass ecosystems are undergoing a profound transformation, when the number of livestock increases simultaneously with plowing of virgin and pasture lands.

So, in the period of the Tuva Autonomous region, acreage areas increased significantly: compared to 1945, by 1960, the area of grain increased more than three times, amounting to 279.8 thousand ha, including wheat – 193.6 thousand ha, barley – 21.7 thousand ha, oats – 34.7 thousand ha, millet – 27.1 thousand ha (Fig. 2). The acreage areas of forage lands has increased by an order of magnitude. The croplands of vegetable and melon crops, including potatoes, which by 1960 amounted to 6.2 thousand ha, and vegetables – 0.6 thousand ha, increased significantly (Fig. 3).

![Figure 2. Dynamics of acreage areas by agricultural crops of TPR in 1945–1960, thousand ha.](image-url)
In 1950-60, the development of virgin land in the country began, which did not pass by Tuva. Of course, the development of virgin land was an erroneous course in agriculture, imposed by party ideology, recognized as such a little later [19]. Nevertheless, it should be noted that there are erroneous works concerning the development of agriculture in the Republic in the 60s of the XX century. Some authors reported that plowing of virgin and fallow lands should be considered significant achievements of agriculture in Tuva [20], while the volume of agricultural land was increased by 1.4 times, plowed in turnover by 4.2 times, and 4.7 times. In addition, the authors pointed to the need to use maize as the main forage crop [21, 22].

More than a million hectares of agricultural lands were lost during the virgin land period (1953 to the 1960s), decreased from 5622 thousand ha to 4489 thousand ha (Fig. 4). In later studies, it was shown that the main factors of wind erosion in Tuva were the unjustified expansion of crops and forage crops, especially maize, the predominance of spring plowing and the use of seed varieties that should not be used in arid climatic conditions. Moreover, it was found that all types of soils are subject to wind erosion in areas of insufficient moisture, "...in sandy and sandy loam soils, erosion begins 2–3 years after the development of virgin land, in light-loam and medium-loam – 4–5 years, and in clay and heavy-loam after 7–10 years" [23]. Thus, the campaign for the development of virgin lands in the country between 1954 and 1963 had a particularly strong impact on vegetation and soil, a significant anthropogenic impact in the steppes will be traced for several centuries. Almost simultaneously with the beginning of large-scale agricultural use of virgin and fallow lands, soil degradation and climate change occur [24].

Figure 3. Dynamics of acreage areas for vegetable and melon crops of TPR in 1945–1960, thousand ha.
As early as in 1967, the large scale of eroded land in Tuva was estimated at 175 thousand ha, including 79 thousand ha of arable land, 65.6 thousand ha of pastures and 30.4 thousand ha of fallow lands [25] (Table 1). It is shown that most of it is caused by wind erosion, which accounted for more than 161 thousand ha or 92% of the area of eroded land. At the same time, more than 2/3 of the land is subject to severe and average wind erosion, including 65.6 thousand ha of pastures and 45.5 thousand ha of arables.

Table 1. Structure and area of eroded lands of the Tuva ASSR according to data from 1967, thousand ha

| Croplands   | Area of eroded land | Including those subject to Wind erosion | Water erosion |
|-------------|---------------------|-----------------------------------------|---------------|
|             |                     | Total by degrees | Weak | Middle | Strong | Total by degrees | Weak | Middle | Strong |
| Arables     | 79.0                | 75.5            | 30.0 | 32.5   | 13.0   | 3.5             | 1.0  | 2.5    | -      |
| Fallow lands| 30.4                | 20.3            | -    | -      | 20.3   | 10.1            | -    | 6.0    | 4.1    |
| Pastures    | 65.6                | 65.6            | -    | 29.0   | 36.6   | -               | -    | -      | -      |
Geographically, zones of erosion are common in the Ubsunur and Central-Tuva basins. The most affected areas are the Erzin, Tes-Khem, Tandy, Kaa-Khem, Ulugh-Khem and Dzun-Khemchik districts, which account for more than 70% of the area of eroded lands. Approximate losses of natural nutrients and fertilizers during soil erosion, which negatively affect productivity, are given: during wind or water erosion of soils on an area of 1 ha, when 2.5 cm of chernozem is blown out and washed away, phosphorus is lost – 196 kg, nitrogen – 981 kg, and organic substances – about 15 tons [26]. In general, erosion processes reduce the yield of agricultural crops by 40–70%, and the efficiency of fertilizer application by 20–30%. At the same time, the yield of areas that are not provided with irrigation systems, depending on weather conditions (wet or dry year), can vary from 1.5–2.5 centner/ha to 12–16 centner/ha.

The period of the Tuva ASSR (1961–1991). By the beginning of 1960, Tuva's agricultural enterprises were being enlarged and grouped into agricultural zones depending on natural and economic conditions: the Central zone included such districts as the Kyzyl, Ulug-Khem, Tandy, Ply-Khem and Kaa-Khem districts, the southern – Erzin, Tes-Khem and Ovyur districts, and the Western – Dzun-Khemchik, Barun-Khemchik, Sut-Khol and Mongun-Taiga districts, to the East – Todzha district. The reasons are financial difficulties and the growing debt of collective farms to the state from year to year. It became possible to increase the acreage [27]. In all categories of farms they reached about 278.3 thousand ha or increased almost 4 times to the level of 1950 (Fig. 5).

Figure 5. Dynamics of acreage areas of grain crops Tuva's agricultural zones (1945–1983), thousand ha.

The study of the structure and dynamics of acreage areas of grain crops in the agricultural zones of Tuva shows that in the 50-60s of the XX century, there is a significant increase in sown areas [19]. Thus, in 1966–1970, in the structure of crops in Tuva, cereals accounted for 230.8 thousand hectares. In
General, the 60–70 years are characterized as the years of formation of large agricultural enterprises in the Republic with a strong production base and labor resources. The development of virgin lands began during the years of a rather acute food crisis in the country. According to the conclusion of leading scientists, the virgin epic as an extensive model for solving the problem has not justified itself either economically or environmentally [28–31].

By 1980, the acreage in the Republic reached 370.7 thousand has, mainly due to an increase in the acreage of cereals and forage crops. During this decade, 1972 was the most productive year – the gross harvest of grain crops amounted to 298.1 thousand tons. Thus, the 70–80 years of the last century in the Republic's agriculture were years of intensification, specialization and concentration of production, wide introduction of economic calculation and other methods of production. However, from 1976 to 1980, there was a downward trend in the rate of agricultural development in the Republic. The main reason for the relatively slow development of the industry was a decrease in the yield of the main agricultural crops: grain, potatoes and vegetables. The reasons were both socio-economic and adverse weather and climate conditions.

The largest area of grain crops was observed in 1980, including 273 thousand ha in the Central region, 70 thousand ha in the West, and 25 thousand ha in the South. At the same time, the Central zone accounts for about 2/3 of the sown area of grain crops, the Western zone – 20%, the southern zone – 5%, and the Eastern zone – only 1%. The same structure of acreage areas of grain crops remains in the future.

According to the structure and dynamics of potato acreage in Tuva, the picture is somewhat different. Interestingly, the largest areas of sown areas were observed in the 1960s – during the virgin land period, when they were more than 5 thousand hectares. since 1965, the sown area of potatoes has not decreased much, amounting to 4.2 thousand hectares in 1970 (Fig. 6). In the structure of potato acreage, the largest share belongs to the Central agricultural zone (79%), followed by the Western zone (18%) and the southern zone (3%). In the Eastern zone, the acreage of cereals and potatoes is minimal.

**Figure 6.** Dynamics of potato acreage in Tuva's agricultural zones (1945–1983), thousand ha.
It should be noted that before 1950, the largest share of sown areas of grain crops was in Ulug-Khem district (12.5 thousand ha), followed by Tandy (12.3 thousand ha), Piy-Khem (9.4 thousand ha), Kaa-Khem (7.2 thousand ha), Barun-Khemchik (7.5 thousand ha) and other districts. Since the 60s of the last century, the situation has changed somewhat – the Tandy district is increasing its grain acreage at a faster pace and by 1983 it accounts for almost a quarter of all the Republic’s grain acreage (Table 2). A significant share of acreage also falls on the Kaa-Khem, Piy-Khem, and Ulug-Khem districts, which traditionally belong to the favorable agriculture of the Central Tuva basin.

Table 2. Acreage areas of grain crops in the districts of Tuva (1945–1983), thousand ha

| Areas       | 1945 | 1950 | 1960 | 1970 | 1980 | 1983 |
|-------------|------|------|------|------|------|------|
| Mongun-Taiga| 0.2  | 0.2  | -    | -    | 0.3  | 0.3  |
| Bai-Taiga   | 3.6  | 4.1  | 9.1  | 8.3  | 9.8  | 7.8  |
| Barun-Khemchik| 6.8  | 7.5  | 18.3 | 18.9 | 14.0 | 13.8 |
| Ovyur       | 1.2  | 1.3  | 1.1  | 1.7  | 2.8  | 1.2  |
| Sut-Khol    | 3.0  | 4.2  | 6.7  | 9.6  | 15.0 | 9.1  |
| Dzun-Khemchik| 5.9  | 6.9  | 28.2 | 33.3 | 30.9 | 23.2 |
| Ulug-Khem   | 12.2 | 12.5 | 48.4 | 43.7 | 47.5 | 32.0 |
| Tandy       | 10.5 | 12.3 | 68.0 | 77.7 | 82.8 | 72.9 |
| Piy-Khem    | 9.1  | 9.4  | 34.6 | 36.3 | 37.9 | 37.5 |
| Todzha      | -    | 0.1  | 0.3  | 2.1  | 2.5  | 2.2  |
| Kaa-Khem    | 6.4  | 7.2  | 40.2 | 54.3 | 55.9 | 44.8 |
| Tes-Khem    | 1.4  | 1.9  | 3.4  | 8.1  | 10.8 | 6.7  |
| Erzin       | 0.7  | 0.8  | 1.3  | 8.5  | 11.1 | 7.7  |
| Kyzyl       | -    | 1.7  | 18.7 | 45.7 | 48.4 | 38.9 |
| **Total for the republic** | **61.0** | **70.1** | **278.3** | **348.2** | **369.7** | **298.1** |

The relatively low starting conditions of the Tuva economy in the pre-reform period, management errors in the planning period, disruption of production and technological links of most enterprises, and many other factors led to a catastrophic reduction in acreage, including grain, between 1980 and 1990. The reduction of grain acreage in 1990 by 1980 was about 40%, including grain by more than two times (Fig. 7).
In General, the years 1960–1990 were the period of formation and development of collective and state farm production in the Republic's agriculture. Years of gradual development of the planned economy. The industry had a good material and technical base. Over the past 30 years, the Republic has achieved a fairly dynamic development of agriculture. At the same time, it is noteworthy that more than 30 thousand people were employed in the agricultural enterprises of the Republic on an average annual basis and had a permanent basis for motivated work.

As a result of the systemic crisis that engulfed Russia in the late 1980s and early 1990s, huge tracts of croplands were withdrawn from circulation [32]. During the period of reforms in the 1990s, negative trends in the country's economy had a more acute impact on the socio-economic development of the Republic of Tyva, given the complex of unresolved social problems, as well as the relative transport isolation of the Republic, which is the only region in Russia that does not have a railway connection with the rest of the country. Such factors as violation of economic relations between agricultural enterprises, processing and sales enterprises, lack of government support, disbandment machine-tractor parks as well as quick wear, disparity of prices for agricultural equipment compared with prices of agricultural products, the lack of tax incentives and soft loans led to the ruin of large farms of agro-industrial complex, which accounted for more than 99% of agricultural products [33] In the new market conditions in Tuva, there is an even greater decrease in the acreage of grain crops. Thus, in 2000, in comparison with 1980, the sown areas of grain decreased by 8.4 times, wheat by 6.7 times, and fodder crops – 11 times.

"...Thousands of arable land turned out to be unclaimed and, gradually overgrown with weeds and other vegetation, began to turn into a Deposit" [34]. According to the materials of D.I. Lyuri and others [29], the Republic of Tuva experienced an unprecedented reduction in the area of arable land – 2.034 thousand ha, which corresponds to 56.9% of the former fund in Tuva before 1990.

Currently, Tuva lags behind most regions of the Siberian Federal district and Russia in many socio-economic parameters. However, there is a slight increase in acreage, but not reaching the acreage even in 2000.

Conclusions
Thus, it is shown that despite the fact that the leading branch of agriculture in the TPR was animal husbandry, crop production developed no less dynamically. During the TAR period, the acreage of cereals, forage land, and vegetable crops, including potatoes, increased significantly. But the unjustified plowing of virgin and fallow lands in the 50s and 60s of the twentieth century led to soil erosion and destruction, and the loss of more than a million hectares of agricultural land. During the period of the Tuva ASSR, there is a further increase in acreage. With the beginning of market reforms, there is a significant decrease in the sown area of grain crops. At present, there is again a slight increase in acreage.

Acknowledgments
The reported study was funded by RFBR according to the research project № 19-29-05208-19 mk

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