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Agriculture in the Baksan Gorge of the Central Caucasus, Kabardino-Balkaria, Russia

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Abstract:
No agriculture is possible without soil. This article reviews available data on the soils of the Baksan Gorge located in the Kabardino-Balkarian Republic, Russia. The research objective was to collect and analyze information on the soil composition and crop yields in this region of the Central Caucasus.

The review covered the last five years of scientific publications cited in Scopus, Web of Science, and Elibrary. It also featured contemporary and archival documents on the soil composition and periglacial agriculture in the Baksan Gorge.

The agriculture and cattle breeding started in the Central Caucasus in the first millennium BC when the local peoples began to develop these lands as highland pastures and, subsequently, for agricultural farming. During the second millennium BC, crop production became one of the most important economic sectors in the Central Caucasus. Corn, barley, wheat, and millet were the main agricultural crops in the Baksan Gorge. Millet has always been a traditional Kabardian crop, and millet farming occupied the largest flatland areas. Barley was the staple crop in the highlands. Currently, the list of local staple crops includes corn, wheat, and sunflower. Barley, oats, peas, potatoes, vegetables, berries, nuts, grapes, and annual herbs are also popular. The past fifteen years have seen an extensive development of intensive horticulture in the Baksan Gorge.

Agricultural ecology and production problems depend on the localization of agriculture in the Central Caucasus. This research reviewed data on the effect of soil composition on the yield and value of agricultural crops in the Baksan Gorge of the Central Caucasus.

Keywords: Land use, crops, soil, Central Caucasus, Baksan Gorge

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INTRODUCTION

Agriculture has expanded into hard-to-reach regions with a harsh climate [1–3]. This global trend is a result of soil depletion and climate change, which reduce the agro-ecological potential of traditional agricultural regions [4, 5]. Russia is extremely heterogeneous in terms of food security [6]. Russian North Caucasus provides itself with agricultural products by more than 80% [7]. Diversification of agricultural production in the regions is an urgent task in the current conditions of import substitution [8]. As a result, some regions may experience difficulties in complying with FAO food security standards [9]. In this regard, agricultural science focuses on the fallow soils in the Russian Arctic and other hard-to-reach regions [10–12].

The current rapid deglaciation of the Central Caucasus has become a source of new lands [13–16]. The deglaciated areas demonstrate good projective plant cover and herbal diversity [17]. The farmers of the Central Caucasus use these new territories as pastures, hayfields, and cultivated lands, thus increasing the local planted acreage.

Sustainable soil development and environmental management are of highest importance in Russia because soil degradation has already destroyed a third of its soil resources [18]. Soil depletion is a relevant issue for the Kabardino-Balkarian part of the Central Caucasus. At present, the available lands of the Kabardino-Balkarian Republic cover 1247 thousand hectares, which is 3.5% of the total available lands of the North Caucasian Economic Region. Agricultural land occupies 627.6 thousand hectares, or 50.3% of the active area, including 284.5 thousand hectares (22.8%) of arable lands. More than 38% of agricultural lands are affected by water and wind erosion, as well as salinization [19].

The research objective was to describe the periglacial agriculture in the Baksan Gorge of Kabardino-Balkaria.

The authors analyzed the agricultural history in the Central Caucasus and studied the local soils and their agricultural application under the harsh orographic and climatic conditions of the Central Caucasus. The research also revealed various aspects of food security in the Central Caucasus.

STUDY OBJECTS AND METHODS

The research covered five years of scientific publications in domestic and foreign peer-reviewed journals on the soil and agriculture of the Central Caucasus. The search parameters included English keywords for Web of Science and Scopus databases and Russian ones for the Elibrary database. The study also featured monographs on the development of Caucasian agriculture. The methods included data analysis, systematization, and generalization.

The paper also introduces some results of laboratory physicochemical studies of the Baksan soils, as well as photographs of soil sections obtained by field research.

RESULTS AND DISCUSSION

Agricultural history of the Central Caucasus. The early first millennium BC saw an active rise of highland tribal communities, who began to develop mountain pastures [20]. The North-Caucasian highlands, with their steep slopes and rocky soils, were unsuitable for crop farming but provided excellent pastures for cattle breeding. For centuries, cattle provided the highlanders with everything they needed. Cattle breeding was the main subsistence in the ancient economy of the North-Caucasian peoples [21]. The progress of crop agriculture was less prominent. However, it was also an important sector of the Central-Caucasian economy in the second millennium BC. The arable plow farming was possible in the flatlands, but highland crop farming developed less intensively [22]. The unfavorable climatic conditions resulted in infertile permafrost and seasonally freezing soils. Together with the complex terrain, they were responsible for the poor agricultural development of the Central-Caucasian highlands. The first arable farming reached these areas together with the general technological development and required a lot of draft power. Nevertheless, crop farming was always part of the ancient economy in all the gorge areas of the Central Caucasus.

Plow farming found little application in the Central-Caucasian highlands with its harsh climate and complex terrain. Hoe farming with its artificial terraces was more efficient. All suitable lands were subjected to agricultural processing, including capes, watershed hill tops, thirty-degree slopes, etc. Steep slopes were terraced to provide extra acreage. In fact, terrace agriculture was practiced in the Central Caucasus until the middle of the 20th century.

Terracing was also popular in other parts of the Caucasus, especially in Dagestan [23]. Agricultural terracing has always been the optimal solution for hilly and mountainous terrains all over the world [24–27]. Ancient Italy was especially famous for its terraces, which proved to be the most effective form of land cultivation in the harsh conditions because terraced slopes prevented soil degradation [28, 29].

In the Central Caucasus, some terraces were as big as 1–1.5 hectares. The bottom of the terrace consisted of large stones and boulders, followed by small stones and yellow clay. The upper layer consisted of imported soil and humus, which were compacted by sheep and cow herds. This method provided the maximal moisture retention. Terrace construction depended on such factors as soil composition, slope angle, vegetation, etc. The terraces performed two important functions: they optimized the relief by reducing the chance of avalanches and mudflows, as well as increased in the acreage [30].

The economic structure of the Central Caucasus has always depended on its topography. The Central Caucasus can be divided into flatlands, foothills, highlands, and alpine areas. The highlands and alpine areas had very little land suitable for plowing, which made the life of the local people a constant struggle with nature. It took the local tribes superhuman efforts to turn the mountain slopes into plowed fields. They literally had to conquer every piece of land from nature by chopping down forests, uprooting shrubs, and removing stone boulders. Irrigation and soil fertilization were also extremely effort-consuming, but the gorges of the Central Caucasus eventually developed a complex network of irrigation canals [31].

Despite the enormous efforts to increase productivity, the yields were still small. The seeds vs. harvest ratio was 1:3, 1:5, or even 1:2 in lean years. Sometimes, farmers even failed to reach a 1:1 ratio [32]. The flatlanders used a heavy limber plow, dragged by three or four pairs of oxen. Highlanders preferred a wooden light plow with an iron share. This tool provided shallow plowing as the plow could loosen only the very surface soil, but this method was more rational because the fertile soil layer was thin anyway [33].

Corn, barley, wheat, and millet were the staple agricultural crops in the Central Caucasus. Most flatlands were allotted for millet, a traditional Kabardian crop. Millet covered almost 40% of the entire acreage [22, 34]. Barley was the staple crop in the highlands. Its varieties were frost-resistant and lowmaintenance in terms of soil because of the harsh climate with its frozen or seasonally freezing soils. Wheat did not survive in the Central-Caucasian highlands because it failed to ripen during the short warm season [35].

Glacial dynamics and expansion of arable soil areas in the Central Caucasus. Like many other mountain-glacier regions these days, the Caucasus has been experiencing a stable deglaciation for several thousand years. Glaciers all over the world are gradually decreasing in number, area, and volume. Elbrus is the largest mountain glacier in Russia. It includes 16 major glacial streams [36]. In 2007, its total ice sheet area was 120 km^2. Elbrus has two big glaciers. The Big Azau is located on the southern slope. It is 9.35 km in length with a total area of 20.2 km^2. The vast Jikiuankez ice field on the northern slope consists of two glaciers, Birjalychiran and Chungurchatchiran. Its total area is 23.4 km^2. The Elbrus ice cap covers several altitudes, descending from the peaks (5642 m) to the bottom of the Big Azau glacier (2542 m) [37, 38].

The first instrumental survey of the entire Elbrus glacier took place in 1887–1890. It resulted in a topographic map at a scale of 1:42 000 [39]. This map served as ground zero for every subsequent glacier survey in this region. A lot of data on the Elbrus deglaciation are available for 1957–1997, when the Elbrus glaciers shrank by 12.5 km^2, i.e., an average of 0.25 km^2 per year. Between 1887 and 2007, the area of Elbrus glaciers decreased by 20% [13, 40, 41]. Climate change is not the only enemy of the Caucasian glaciers: cryoconites reduce the surface albedo and thereby accelerate the melting [14, 15].

The mass balance of glaciers on the southern Elbrus dropped by half over the past two decades and amounted to 63 cm w.e., i.e., water equivalent. Between 2010 and 2018, its average value dropped to 90.4 cm w.e. The ice and perennial firns accumulated in the second half of the XX century are melting at an unprecedented rate: they are almost exhausted over a large area at the altitude of 3700–4000 m. The glacier feeding boundary has risen by 200 m, and the firn consumption is increasing. The ablation area has melted down to lava ridges. The cumulative mass balance has reached its minimum value over the past 50 years [42].

As the Central-Caucasian glaciers continue to retreat, the periglacial landscapes of the Baksan Gorge continue to grow. The periglacial Bashkara area increased significantly in 1996–2006. In the ten years it took the grass line to move 10–20 m up the slope, the projective cover and herbal diversity also increased dramatically [17]. Residents of the Baksan Gorge use the former glacier areas that are now covered by grass. These territories still freeze in winter or remain cryosolic, but they serve as pastures and hayfields in warm seasons. In their turn, the lands that were previously used as pastures and hayfields gradually become arable. The agricultural area is expanding, which is very important in mountainous areas where arable soil is scarce.

Soils of the Baksan Gorge and their agricultural application. The Baksan Gorge boasts a wide variety of geomorphological forms and climatic conditions, which affected the local soil-forming processes and agriculture. Foothill farmers mostly grow wheat, corn, and sunflower (Fig. 1), not to mention fruit and vegetables. The highland and alpine areas with their permafrost and seasonal freezing develop meat and dairy farming, sheep breeding, etc., and the local agricultural lands are mostly pastures and hayfields [43, 44].

The soils of the Baksan Gorge are diverse, depending on the altitude and the bank of the Baksan River [44–46]. The right bank of the Baksan River is covered by forests of pine, pine and birch, birch and pine, and birch. They host a wide variety of mountain forest soils (Fig. 2).

Mountain forest-meadow soils develop under the birch crooked forests that cover the northern slopes. These soils have a prominent humus-accumulative horizon and residual weathering. The mechanical

Figure 1 Crops cultivated in the foothills of the Baksan Gorge (photo by R.Kh. Tembotov)

a b c

Figure 2 Profiles of mountain forest soils in the Baksan Gorge: mountain forest-meadow soil (A), mountain brown forest soil (B), and Mountain dark-grey forest soil (C) (photo by R.Kh. Tembotov)

Table 1 Mountain woodland soils of the Baksan Gorge: physical and chemical parameters of upper horizons (0–20 cm)

Soil	pH (H_2O)	Density, g/cm^3	Humus	
			Content, %	Stocks, t/ha
Mountain forest-meadow	6.0	–	5.9	–
Mountain brown forest	6.6	0.9	12.1	199
Mountain dark-grey forest	6.3	0.90	7.4	148

composition reflects the redistribution of chemical elements along the profile. Table 1 contains some physical and chemical characteristics of mountain forest-meadow soils defined as part of this research. These indicators are similar to mountain forest-meadow soils in other regions of Russia. For instance, the humus content in the South Urals is 5–7%, and the soil is slightly acidic. In the South-Eastern Transbaikalia, the humus content reaches 8–9%, and the soil is slightly acidic, too [47]. Mountain forest-meadow soils are of little agricultural use since they occur mostly in forests. In places like the Baksan Gorge, mountain forest-meadow soils are available for grazing and haymaking, and few areas are free from forest vegetation.

Mountain brown forest soils are common in the highlands and in the alpine forests between 800 and 1800 m above sea level, on watershed hill tops, and on the northern slopes of various steepness. These soils are formed by eluvial rocks and talus, e.g., sandstone, clay, limestone, and granite. Mountain brown forest soils have no distinct genetic horizons. They are relatively uniform in color: brown or brownish-fallow. The humus content depends on the depth: its powdery and granular structure becomes nutty and lumpy in B-horizon. The thickness of the humus profile ranges from 23 to 38 cm, while its mechanical composition varies from heavy to light loamy.

Table 1 features the main physical and chemical characteristics of the mountain brown forest soils of the Baksan Gorge. The dense forestation of the terrain prevents its agricultural application: only forest meadows can be used as hayfields. In the Kaliningrad Region, however, mountain brown forest soils are used not only for pastures and hayfields, but also for arable land [48].

Mountain dark-grey forest soils develop in the forest-steppe zone of low-altitude mountains covered by post-forest meadows and broad-leaved forests under partially percolative water regime. The parent-rock material is represented by carbonate clays, talus, and heavy-clay loams. Mountain dark-grey forest soils have a weak morphological differentiation of organic matter in the upper profile, thick A-horizon humus, and no morphologically pronounced podzolization. The A-horizon humus is 25 cm thick. The mechanical composition is loamy with fractions of fine sand and silt. Table 1 features the main physical and chemical properties of mountain dark-grey forest soils of the Baksan Gorge. In other regions, dark-grey forest soils have a similar humus content (4.7–8%) from slightly acidic to neutral [49]. In the Baksan Gorge, forest-free dark-grey forest soils are used for crop farming, gardening, hayfields, or pastures.

Figure 3 illustrates the mountain-meadow soils in the left-bank alpine part of the gorge, covered with under alpine and subalpine vegetation.

The mountain-meadow alpine soils of the Baksan Gorge appeared under alpine meadows under percolative water regime and low temperatures. These soils are located in the alpine zone, on slopes of various steepness

a b c

Figure 3 Profiles of mountain-meadow soils in the Baksan Gorge: mountain-meadow alpine soil (a), mountain-meadow subalpine soil (b), and mountain meadow-steppe subalpine soil (c) (photo by R.Kh. Tembotov)

Table 2 Mountain-meadow soils of the Baksan Gorge: physical and chemical parameters of upper horizons (0–20 cm)

Soil	pH (H_2O)	Density, g/cm^3	Humus	
			Content, %	Stocks, t/ha
Mountain-meadow alpine	4.4	0.7	11.7	162
Mountain-meadow subalpine	5.7	0.66	15.3	202
Mountain meadow-steppe subalpine	5.6	0.95	13.6	256

and exposure. The incomplete set of genetic horizons in the profile is their specific feature. The A-horizon humus profile is up to 20 cm thick. It has a dark-brown color and a powdery structure. The underlying horizons are yellowish-brown and structureless. The parent rock is represented by acidic residual deposits and talus. The soil profile is rock-debris and stones, while the mechanical composition is from medium loamy to light loamy.

Table 2 presents the mean values of the physical and chemical characteristics of this type of soils. The mountain-meadow alpine soils of the Western Caucasus have the same acidity (4.4) as those of the Central Caucasus, but a higher humus content (14.3%). The high humus content is a direct result of the humid climate and the corresponding patterns of organic transformation. The decomposition of organic matter occurs slowly, resulting in a robust accumulation of semi-decomposed organic matter [50]. The Baksan mountain-meadow alpine soils serve as summer pastures.

Mountain-meadow subalpine soils are to be found on the slopes of the Lateral (Bokovoi) and Rocky (Skalisty) Ridges of various steepness. In the subalpine bioclimatic zone, they develop at low temperatures beneath subalpine and post-forest meadow vegetation under percolative water regime. The parent rocks are represented by unsaturated siallitic weathering detritus of non-carbonate dense sedimentary and massive crystalline rocks. As a rule, they are residual deposits and talus of non-carbonate bedrocks, with accidental loose sediments. Mountain-meadow subalpine soils develop in the cold and humid alpine climate. They are usually medium-thick: 20–40 cm. The soil has no distinct genetic horizons, the transitions between the horizons are smooth. The upper horizons are dark brown with a gray tint, which changes to light brown downwards.

Table 2 presents the mean values of the physical and chemical characteristics of these soils. In the Western Caucasus, mountain-meadow subalpine soils are more acidic. Unlike alpine soils, they are more humus-rich than in the Baksan Gorge [50]. In other regions, mountain-meadow alpine and subalpine soils serve as distant pastures [51]. In the Baksan Gorge, they can be used hayfields or pastures.

Mountain meadow-steppe subalpine soils appear in xeromorphic areas among the mountain-meadow soils of the southern, southeastern, and eastern slopes of the Lateral (Bokovoi) and Rocky (Skalisty) Ridges of the Baksan Gorge. The parent-rock material is weathering detritus of dense sedimentary non-carbonate rocks, and the soil cover is represented by combinations of soils of different thickness, stone content, and removal. The soil profile ranges from 20–25 to 40–50 cm. It is grass-covered, with no distinct horizons. A-horizon is dark brown, changing to yellowish-brown downwards; the compaction is weak. Table 2 presents the mean values of the physical and chemical characteristics of this type of soil. In other Caucasian areas, mountain meadow-

a b c

Figure 4 Profiles of highland and foothill soils of the Baksan Gorge: sod-calcareous soil (a), mountain-meadow chernozem-likes soil (b), and mountain leached chernozem (c) (photo by R.Kh. Tembotov)

Table 3 Highland and foothill soils of the Baksan Gorge: physical and chemical parameters of upper horizons (0–20 cm)

Soil	pH(H_2O)	Density, g/cm^3	Humus	
			Content, %	Stocks, t/ha
Mountain sod-calcareous	7.7	0.70	13.2	178
Mountain-meadow chernozem-likes	6.9	0.90	11.0	197
Mountain leached chernozems	7.7	1.01	10.2	197
Mountain leached agricultural chernozems	7.9	1.21	6.5	105

steppe soils are more alkaline (pH 6.1), but their humus content (9.2%) is lower than in the Baksan Gorge [52]. Mountain meadow-steppe subalpine soils are used as pastures in the Baksan Gorge and in the rest of the Caucasus.

Figure 4 shows mountain sod-calcareous, mountain-meadow chernozem-likes, and mountain leached chernozem soils that developed in the highlands and foothills of the Baksan Gorge, in the belt of steppe meadows, and in the meadow steppes proper.

Mountain sod-calcareous soils are common in the forest-steppe zone on the watershed hill tops, as well as on slopes of various steepness and exposure. These soils develop on less weathered and thin limestone residual deposits and talus. They have no distinct profile, as well as a lot of rubble and rocks. The humus horizon is dark and granular or lumpy-granular. The mechanical composition is medium loamy with fractions of coarse and fine dust.

Table 3 presents the mean values of the physical and chemical characteristics of mountain sod-calcareous soils, determined as part of this research. These soils are quite suitable for grain crops. However, the climate is unfavorable, and these soils are located on the steep slopes of the Baksan Gorge. As a result, they serve only as hayfields and pastures. Sod-calcareous soils make excellent vineyards in humid boreal and subboreal conditions [53].

Mountain-meadow chernozem-likes soils develop in the bottom subalpine belt, covered by steppe subalpine meadow and meadow vegetation. The humus horizon is dark gray, with a brownish tint. Their fine-grained structure changes to fine cloddy downwards. These soils are well-compacted and porous. They contain a lot of roots, rubble, and rocks, the number of which increases with depth. The humus profile is 43–48 cm in the thick subtypes, 34.8 cm in the medium-thick subtypes, and 18–12 cm in the thin subtypes. The mechanical composition is medium to heavy loamy. Table 3 presents the mean values of the physical and chemical properties of mountain-meadow chernozem-likes soils. In the Western and Eastern Caucasus, these soils are neutral or slightly alkaline (pH 6–7.1), with a very high humus content (12–15.3%), like in the Central Caucasus [54]. These soils possess a rather high potential fertility. However, they are used as highly productive hayfields and pastures all over the Caucasus because the harsh climate and complex terrain prevent the local farmers from using them for crop cultivation.

Mountain leached chernozems are located on the northern slope of the Chalk (Melovoy) Range. They appear in the mountain-steppe belt, some 700–1200 m above sea level, which is under meadow steppes and steppes proper. These soils are a result of partially percolative water regime. They also develop on watershed hill tops and slopes of different steepness, mainly in the northwestern, northeastern, and northern

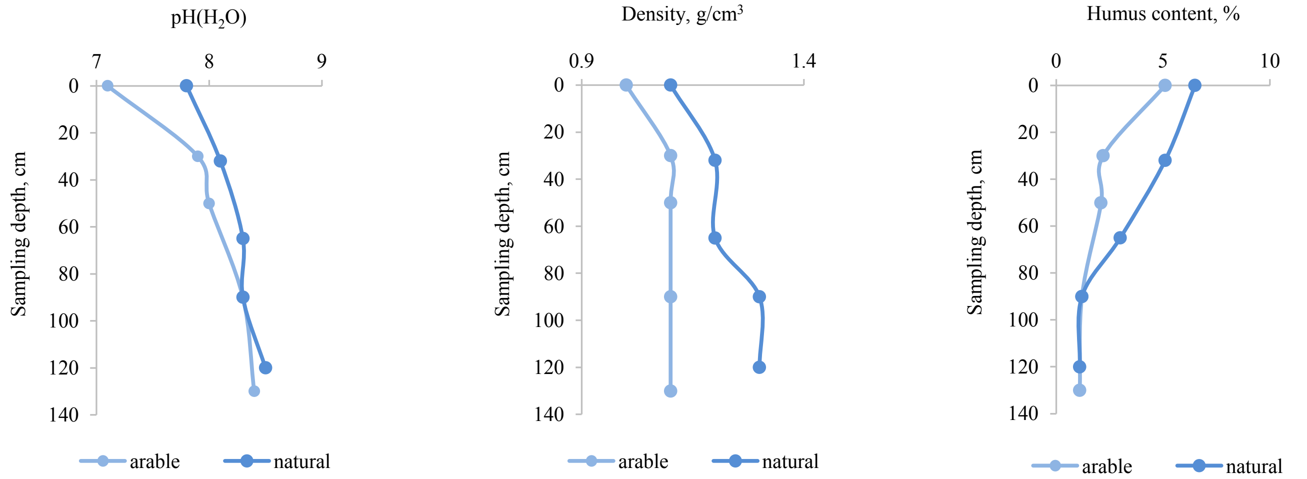

Figure 5 Mountain leached chernozems in the Baksan Gorge: changes in the physical and chemical parameters

exposures. They are located on the residual deposits and talus of limestones, calcareous sandstones, carbonate loams, and clays. Mountain leached chernozems have great agricultural prospects. Their properties make it possible to use them for all zonal crops and perennial plantations.

Table 3 shows the physical and chemical properties of these soils. Mountain leached chernozems are the main arable soils of the Baksan Gorge. That is why Table 3 also presents some physical and chemical properties of mountain agrogenic leached chernozems. A comparative analysis of natural and arable mountain leached chernozems demonstrates that agricultural use results in a greater compaction of the upper soil horizons and a significant loss of humus [55]. The entire soil profile is important for agricultural crops in the Baksan Gorge, especially for sunflower and corn. According to Khakunova *et al*., the profile changes its physical and chemical parameters downwards (Fig. 5) [55]. The humus content goes down sharply, like in leached chernozems elsewhere [56, 57].

Food security in the Central Caucasus. The entire human history is a never-ending search for new methods to meet the basic needs to sustain society, especially in food production. As a result, the existing agricultural systems are adapted to a particular geographical context. They maintain a fragile balance between the basic human needs and the sustainability of the resource [58]. However, people have been trying to adapt the environment for their needs [59]. Extensive agricultural practices changed the landscape, thus becoming a multifunctional agent [60]. This role is especially typical of mountain agriculture with its low-productivity and high-quality focus. These agricultural systems are dominated by grazing and perennial crops, e.g., orchards, vineyards, etc. As a rule, mountain regions have fewer agricultural holdings compared to the national averages. Geographic constraints reduce labor productivity in the highlands by 28% compared to less favorable areas and by 40% compared to valley farming.

The Federal Law on Organic Products and Amendments to Certain Legislative Acts of the Russian Federation was adopted in 2018 and entered into force on January 1, 2020 [61]. This law obliges all Russian regions to localize agricultural products and introduce the best organic farming practices. The transition to a highly productive and green agricultural economy requires a deep analysis of soil resources of fallow and arable lands, including those that appeared as a result of deglaciation [62, 63]. Russian active and fallow agroecosystems are unique systems represented by models of development, degradation, progradation, and evolution of biogeocenosis in space and time as a result of the multidirectional agrogenic impact that occurred in the 20th century [64, 65]. The Central Caucasus is of particular interest because the region is currently experiencing a turbulent agricultural development of lands available after deglaciation [13, 17, 37]. The Baksan lands possess an enormous food security potential for the entire Central Caucasus. The local farmers are eager to develop the ice-free areas as pastures, hayfields, and crop farms, thus increasing the acreage in the region.

Mountain-meadow ecosystems are essential for the sustainable development of mountain areas as providers of various ecosystem services, e.g., regulation, culture, food, etc. [66–68]. Long-term overgrazing leads to soil degradation of mountain meadows, a lower humus content in the fertile layer, a greater compaction of the upper horizons, a lower humidity, and a change in microbial indicators [69, 70]. However, no grazing also destroys the biodiversity of mountain meadows, increases tree and shrub vegetation, develops excessive turfiness, and promotes plants of low nutritional value [71, 72].

The effective management of mountain meadows should be based on sustainable consumption of natural resources, i.e., an optimal ratio between the economic use of resources, their renewal rate, biodiversity, and ecosystem integrity [73–75]. A combination of various plant, soil, landscape, economic, and organizational indicators helps recognize the stages of pasture change in mountain meadow ecosystems [76–78]. This system needs optimal indicators to assess the state of a particular meadow under certain environmental conditions.

The stages of pasture digression should correspond with particular grazing rates. The lack of clear ideas about this correlation is especially relevant for the highlands of the Central Caucasus. The scale of pasture pressure in the region is so great that researchers recognize all mountain meadows in the Central and North Caucasus as semi-natural pasture ecosystems that have formed after centuries of constant grazing [79]. The rental land use, which is currently operating in the territory of Kabardino-Balkaria, affects food security in the mountain-meadow ecosystems of the Baksan Gorge [80]. This situation is also typical of other regions with pronounced diversification and numerous small farms, especially in the Carpathians [81, 82]. In the Central Caucasus, this type of land use leads to unsystematic exploitation of agricultural land [83].

The Central Caucasus is an intensively developing tourist and recreational cluster. The resulting labor reorientation of the local population means that agriculture does not attract young people any more. The same crisis of traditional trade is observed in mountainous regions all over the world [84]. The agricultural development of the Baksan valleys and foothills suffer from the general improper disposal of land resources in Kabardino-Balkaria. The fertile soils of the Baksan valleys and foothills are now allocated for intensive orchard farming [85]. A more rational approach to Central-Caucasian agriculture requires more fertile flat soils for grain crops, while medium and high-intensity adaptive gardens should be cultivated in the foothills and forest-mountain zones or on hillsides and slopes that are unsuitable for arable land because of the complex terrain and harsh climate.

CONCLUSION

The recent decades have seen a rapid deglaciation of the Central Caucasus. On the one hand, such an unprecedented deglaciation rate is bad for the environment. On the other hand, the area of periglacial landscapes is growing. The new ice-free areas are undergoing an intensive agricultural development. Although they are still affected by seasonal freezing and permafrost, they can serve as pastures and hayfields in the summer. The lands that were previously used as pastures and hayfields gradually turn into arable land, which significantly increases the amount of acreage. This expansion is extremely important for the Central Caucasus, where the amount of arable land is extremely low.

Kabardino-Balkaria is a predominantly agrarian republic with about 55% of arable land. Horticulture has become very popular here in recent years. The republic plants intensive and innovative orchards and fruit tree nurseries. Traditionally, Kabardino-Balkaria is one of the five leading regions in the country in this sphere.

The main threat to food security in the region is that 80% of agricultural products come from its 1500 farms, 6500 land holders and sole entrepreneurs, and more than 115 000 personal subsidiary plots. As a rule, arable land is used on a short-term lease, and small farmers can provide no rational crop rotation, no proper agricultural technology, and no fertilizers. Moreover, the local population gradually turns to the robust sphere of recreation and tourism, which discourages the young generation from engaging in agricultural business.

CONTRIBUTION

The authors were equally involved in the research and are equally responsible for any potential plagiarism. E.V. Abakumov supervised the project and wrote the manuscript. R.Kh. Tembotov collected the materials, performed the analytical work, and wrote the manuscript.

CONFLICT OF INTEREST

The authors declare that they have no competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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