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STUDY OF THE RECLAMATION STATE OF THE ROCKY CHESTNUT LANDS OF THE REPUBLIC OF ARMENIA AND WAYS OF IMPROVING

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Improvement and effective use of unused land in conditions of land poor of the Republic of Armenia is one of the crucial problems in the field of agriculture. The purpose of the work has been to study the reclamation condition of the uncultivated chestnut lands of the Republic of Armenia and recommend a system of measures to improve them for involvement in agricultural turnover. The chemical and physical properties of the lands have been studied, as well as the degree of rockiness, and the content of nutrients. It has been shown that the lands are characterized by medium and firm rockiness, the presence of cemented horizons, weak and medium clay-loam mechanical composition, and medium and firm calcareousness. Land reclamation measures have been proposed, which will allow the establishment of perennial plantings on the territory.

Reclamation – rocky – improvement – cemented horizon – polluted – degradation

ՀՀ սակավահողության պայմաններում անօգտագործելի հողերի բարելավումը և արդյունավետ օգտագործումը գյուղատնտեսության ոլորտի կարևոր հիմնախնդիրներից են: Աշխատանքի նպատակն է եղել ուսումնասիրել ՀՀ չմշակվող շագանակագույն քարքարոտ հողերի մելիորատիվ վիճակը և առաջարկել դրանց բարելավման միջոցառումների համակարգ՝ գյուղատնտեսական շրջանառության մեջ ներգրավելու համար: Հետազոտվել են հողերի քիմիական և ֆիզիկական հատկությունները, քարքարոտության աստիճանը, սննդատարրերի պարունակությունը: Ցույց է տրվել, որ հողերը բնութագրվում են միջին և ուժեղ քարքարոտությամբ, ցեմենտացած հորիզոնների առկայությամբ, թույլ և միջին կավավազային մեխանիկական կազմով, միջին և ուժեղ կարբոնատությամբ: Առաջարկվել են հողերի բարելավման մելիորատիվ միջոցառումներ, որոնք թույլ կտան տարածքում հիմնել բազմամյա տնկարկներ:

Մելիորացիա – քարքարոտ – բարելավում – ցեմենտացած հորիզոն – դեգրադացիա

Улучшение и эффективное использование неиспользуемых земель в условиях малоземелья Республики Армения является одной из важнейших проблем в области сельского хозяйства. Целью работы было изучить мелиоративное состояние необрабатываемых каштановых земель Республики Армения и рекомендовать систему мер по их улучшению для вовлечения в сельскохозяйственный оборот. Были изучены химические и физические свойства почв, а также степень каменистости и содержание питательных веществ. Было показано, что земли характеризуются средней и твердой каменистостью, наличием сцемен-

тированных горизонтов, слабым и средним глинисто-суглинистым механическим составом, а также средней и сильной карбонатностью. Были предложены мелиоративные мероприятия, которые позволят создать на территории многолетние насаждения.

Мелиорация – каменистость – улучшение – цементированный горизонт – деградация

In the context of global climate change due to rising temperatures, lack of irrigation water, and improper land use by people, the processes of land degradation are developing with great force (1, 3, 11). Considering the case of land-poor Armenia, there are about 24.5 thousand hectares of saline-alkaline, 15.0 thousand of hectares secondary saline-alkaline soils, 11.0 thousand hectares of wetlands, about 34.5 thousand hectares of rocky lands, 50.0 thousand hectares of lands polluted by technogenic elements (13, 2, 6, 10). Armenia has 942.23 ha of unused lands, of which 463.95 ha are rockiness lands. The abovementioned lands can not be used for agricultural purposes without melioration. The total area of unusable land is increasing year by year, which is due to degradation processes. It should be noted that 74 thousand hectares of unused lands are void of the surface fertile soil layer, and 623.3 thousand hectares are eroded in various degrees. Ten thousand hectares of flinty lands in Soviet Armenia were brought under cultivation, where perennial plantings were cultivated. We should note that improvement works require too high capital investments. Consequently, there is a need to change approaches in the process of land improvement, such as local land improvement (when only the area of crop nutrition is radically improved), which can be facilitated by modern, powerful technical means, as well as the introduction of a drip irrigation system that reduces the area of nutrition, as well as volumes and losses of irrigation water.

According to the conducted research, it is possible to improve about 100 thousand hectares of the land plot and be involved in agricultural turnover in Armenia. However, in recent years, it has been increased uncultivated land plots, amounting to 50% of cultivated land plots, connected to a number of socio-economic and other reasons. In the conditions of the land-scarce Republic of Armenia, the proper and efficient use of lands, an increase in fertility, improvement of saline-alkaline, heavy metal-contaminated, rocky lands, and their involvement in agriculture have of great importance for the development of the country's economy.

The soils salinization and alkalization processes are global issues that have a negative impact on the chemical and physical properties of soils, resulting in reduced agricultural productivity. For the sustainable development of agriculture, it is important to improve the ameliorative-ecological condition of saline lands by using different ameliorators (5, 8, 9).

Reclamation of rocky soils is of paramount importance for the efficient use of land resources. Vast plots of land in the foothills and mountainous regions of the country, which are often quite fertile, are not used due to rocky conditions.

Rockiness is known to reduce the agricultural value of lands. The surface, semi-buried, and buried stones are complicated and often exclude the implementation of necessary agrotechnical and reclamation works; they reduce soil fertility. Therefore, improving rocky lands and increasing their productivity is critical and requires immediate solutions.

Materials and methods. The object of study was a land plot with an area of 50 hectares in the Parpi community of the Aragatsotn region of the Republic of Armenia, which was located 700 m north of the Ashtarak-Gyumri highway, at an altitude of 1100-1150 m above sea level, in the zone of distribution of chestnut lands (fig. 1). The studied area had various inclination levels, mid

and low-level rocky surfaces, often with half-buried stones and in places with deep rock formations. Still, overall it was a pasture land with an even surface.

Fig. 1. Rocky land plot of Parpi community

The purpose of the study was to study the degree of rockiness of the mentioned land plot, the chemical composition of the soils, and, based on the research results, to develop ways to improve these lands.

Forty soil diggings of different depths were laid in the study area, depending on the digging ability (30-100 cm). The degree of rockiness of the lands, the chemical composition of the soil solution, the content of available nutrients and humus were studied in the mentioned area. The chemical composition of the soil solution and general chemical analyses were carried out by accepted methods, according to Arinushkina (12).

The kind and degree of rockiness were determined during the research work to organize the technological process of stone cleaning properly. The nature of the rockiness is characterized by the fractional composition of stones (large, medium, and small), as well as their location (surface, semi-buried, and buried) (7).

For agricultural field research, soil digging with a length of 1m 25 cm, a width of 80 cm, and a depth of 30-100 cm were installed in the study area, depending on the digging ability. During the cutting, the stones removed from different layers were isolated and stacked in the form of a known geometric shape; the volume was determined so that the quantitative calculation of the stones would be correct. Based on the number of stones removed from the soil digging, the number of stones per 1 hectare was determined. During the calculation of the stones, stones of different diameters (10-15, 15-30, 30-50, and more than 50 cm) were sorted out. After calculating the amount of removed stones, it was multiplied by a factor of 0.7 or 0.8, depending on the degree of porosity of the heap of stones. To convert the obtained data into m^3 t/ha, it was multiplied by the volumetric weight of those stones.

There was a calculation of the degree of rockiness of the soil in parallel with the establishment of the land digging. The calculation was done by grouping the stones in diameter and location rather than the usual method.

The number of surface and semi-buried stones was calculated using the following formula:

$$P = (h \cdot b \cdot l \cdot y \cdot k \cdot k1) + P1$$

P- The weight of stones in 1 hectare

h- The height of collected stones

b- Width, m

l- Length, m

y - The volume weight of stones for tuff and other porous rocks 1.2-1.8 t/m^3, basalt, and other rocks with a solid structure 2.0-2.5 t/m^3.

k - The sorted stones' porosity coefficient is 0.7 for large stones and 0.8 for small stones.

P_1 - The weight of large stones from 30 cm

K_1 - The coefficient for expressing the weight of the stones of the calculated plot to a hectare.

Deep rockiness had been determined based on the number of stones that were removed from the soil cut. All stones with a diameter of more than 10 cm, removed from the cut, had been classed in the form of a rectangular parallelepiped, the volume had been measured and turned into t/ha with the following formula:

$$P = (h \cdot b \cdot l \cdot y \cdot k)10000$$

In the land use and amelioration, the definition of land digging capability is no less critical than the estimation of rockiness state, as the direction of the future use of these lands mainly depends on that specification. The land plots were dug at a 30-100 cm depth in the mentioned land.

In the first stage of using these lands, surface and buried rocks were collected with the help of special quarrying tractors (Komatsu), and the piled stones were removed with the help of special couplings in pre-separated places and heaped. The humus-rich soil was removed and piled up for more profound reclamation work in the next stage. Then, with the help of powerful crushers, the soil was plowed to a depth of 1 m, and with the help of a unique quarrying mechanism (the distance between the teeth should not exceed 15 cm), the stones coming out of the soil layer were collected. The second deep baking was performed vertically at the first deep baking at a depth of 1 m again. The stones that came out of the soil were collected and taken out.

Blasting operations were carried out to remove massive stones of rock formation from the studied lands.

Holes were made in the intermittent rock layers, explosives were placed, and then the fragments, formed by the explosion, were removed from the soil layer (fig. 2).

Fig, 2. The removing process of massive stones of rock formation

Results and Discussion. The results of the field research showed that the soils of the study area, according to the strength of the drilling capacity, are poorly drilled (when the thickness of the dug layer does not exceed 50 cm), as well as intensely drilled soils (when the dug layer is greater than 70 cm).

The degree of surface and deep rockiness of the soils has been studied. Studies have shown that the soils are mostly medium (151-300 t/ha) and strongly (301-500 t/ha).

There were intermittent bedrocks in the land and illuvial-cemented horizons, which were destroyed by the explosion. The presence of illuvial-cemented horizons is due to the accumulation of large amounts of carbonates in the soil layer, depending on the hydrothermal regime. Such horizons are an obstacle to fully developing the plant's root system. The results of the chemical composition of the studied soil water traction showed that the soils were not saline, the content of water-soluble salts in the profile was 0.072-0.096 %, CO_3, the toxic ion was absent, the reaction of the soil solution - the pH fluctuated in the range of 7.6-7.8 (Table 1).

Table 1. The Composition of the Water-Soluble Salts of the Soil Samples of the Studied Area

Cut	Depth, cm	pH	Salts,%	Soluble ions, mmol/100 g of soil						
				CO^{2-}_3	HCO^-_3	Cl^-	SO^{2-}_4	Ca^{2+}	Mg^{2+}	$Na^+ + K^+$
1	0-22	7.8	0.089	none	0.75	0.25	0.33	0.60	0.48	0.25
	22-40	7.6	0.087	-	0.80	0.31	0.10	0.55	0.40	0.26
2	0-20	7.7	0.084	-	0.72	0.37	0.13	0.50	0.48	0.24
	20-50	7.8	0.086	-	0.80	0.31	0.10	0.60	0.48	0.13
3	0-35	7.7	0.092	-	0.80	0.37	0.14	0.65	0.50	0.16
6	0-40	7.8	0.086	-	0.72	0.28	0.24	0.55	0.48	0.21
7	0-24	7.7	0.082	-	0.72	0.20	0.20	0.50	0.32	0.30
8	0-40	7.7	0.087	-	0.67	0.37	0.28	0.60	0.56	0.16
9	0-30	7.8	0.072	-	0.75	0.20	0.11	0.45	0.40	0.21
10	0-22	7.6	0.077	-	0.67	0.25	0.15	0.50	0.32	0.25
15	0-35	7.8	0.081	-	0.72	0.20	0.25	0.55	0.48	0.14
17	0-30	7.6	0.092	-	0.80	0.25	0.28	0.60	0.48	0.25
19	0-30	7.8	0.091	-	0.75	0.31	0.23	0.65	0.40	0.24

The carbonate of the soils was also studied; it was found that the soils in the mentioned land are moderately strong carbonate (1.8-18.1%), which is due to the presence of cemented layers in some areas (Table 2).

Table 2. Physico-chemical parameters of the soils

Cut	Depth, cm	Calcareousness, %			Adsorbed cations, mmol/100g of soil			Total, mmol/ 100g of soil	Adsorbed cations, %			
		$CaCO_3$	$MgCO_3$	Ca	Mg	Na	K		Ca	Mg	Na	K
1	0-22	2.3	0.8	24.5	0.6	0.7	0.6	26.4	92.8	2.3	2.6	2.3
	22-40	10.6	0.6	23.0	0.4	0.6	0.5	24.5	94.0	1.6	2.4	2.0
2	0-20	2.1	0.9	27.6	0.7	0.6	0.6	29.5	93.6	2.4	2.0	2.0
	20-50	18.4	0.6	17.0	0.4	0.8	0.4	18.6	91.4	2.1	4.4	2.1
3	0-35	10.6	0.7	23.4	0.4	0.7	0.6	25.1	93.2	1.6	2.8	2.4
6	0-40	15.9	0.4	25.1	0.3	0.7	0.4	26.5	94.7	1.2	2.6	1.5
7	0-24	2.3	0.8	24.6	0.7	0.6	0.7	26.8	92.5	2.6	2.3	2.6
8	0-40	18.1	0.5	21.0	0.4	0.8	0.4	22.6	92.9	1.8	3.5	1.8
9	0-30	4.3	0.4	26.0	0.6	0.7	0.6	27.9	93.2	2.2	2.5	2.1
10	0-22	1.8	0.7	24.6	0.7	0.6	0.7	26.6	92.5	2.6	2.3	2.6
15	0-35	14.1	0.6	27.0	0.5	0.6	0.6	28.7	94.0	1.8	2.1	2.1
17	0-30	16.3	0.6	23.9	0.5	0.7	0.6	25.7	93.0	1.9	2.7	2.4
19	0-30	12.9	0.6	28.3	0.6	0.7	0.5	30.1	94.0	2.0	2.3	1.7

The composition and ratio of the exchange cations of the soils were studied. The amount of Ca prevails in the composition of the exchange cations of the lands, which is 91.4% of the total amount of adsorbed cations, the content of adsorbed Na is below the permissible limit (up to 15%).

According to the laboratory research results, the soils have a weak to medium clay-sand mechanical composition, and the humus content in the studied soils is 0.6-3.4%. The soils are poorly supplied with nutrients such as nitrogen and phosphorus and moderately good - potassium (Table 3).

Table 3. The Laboratory Research Parameters of the Mechanical Composition, the Quantities of Humus and Available Nutrients in the Studied Soil Samples

Cut	Depth, cm	Mechanical composition	Humus, %	Available nutrients, mmol/100g of soil		
				N	P_2O_5	K_2O
1	0-22	59.28	1.5	3.51	2.67	29.44
	22-40	33.32	1.8	0.74	1.67	15.20
2	0-20	39.32	2.1	2.85	2.66	129.28
	20-50	41.24	0.6	2.17	2.47	128.16
3	0-35	40.4	3.0	4.29	2.00	64.00
6	0-40	40.4	2.8	4.94	1.66	26.24
7	0-24	32.88	2.8	2.86	2.01	28.40
8	0-40	29.6	3.1	1.43	2.33	43.28
9	0-30	46.6	3.1	2.88	2.32	40.56
10	0-22	47.30	3.4	2.17	2.00	54.24
15	0-35	41.76	2.2	2.82	2.01	35.04
17	0-30	38.35	3.1	2.85	1.33	31.84
19	0-30	32.64	2.7	0.76	1.68	28.24

The ameliorated land plot is planned to be planted with perennial plantations, the root system of which extends mainly to the deep layers of the soil; therefore, it is necessary to create favorable conditions for the uniform distribution of the roots.

Conclusion

1. Studying the ameliorative condition of the rocky brown soils of the Republic of Armenia, it turned out that
   The studied soils are not saline; calcium is predominant in the adsorbed cations, and the amount of adsorbed sodium is within the allowable range.
2. The soils are characterized by weak and medium clay-sand mechanical composition and medium-strong carbonation, which is due to cemented horizons.
3. According to drilling capacity, the soils are poorly and strongly diggable soils, characterized by medium (151-300 t/ha) and strong (301-500 t/ha) shallow, deep rocky soils.

It will be possible to include these lands in agricultural circulation after reclamation.

Suggestions

1. To realise removing of surface and semiburied stones maintaining humus horizon of soil.
2. To remove cemented layers with the help of a powerful leavening machine (Komatsu) to realize loosening with a width of 80 cm, a depth of 100 cm in rows of perennial plantings, collecting and removing large stones.
3. Trees should be planted in the way of the planting hole, removing the soil previously and preparing the soil mixture, which will consist of the soil brought from the humus horizon and three buckets of rotten manure.
4. Considering the extensive slopes of the territory and the degree of rockiness, the irrigation of the territory is realized by the drip method.

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