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HYDROPHYSICAL PROPERTIES OF RAINFED SOILS IN THE NORTHERN PART OF THE TURKISTAN MOUNTAIN RANGE**Mamaraimov Dilshod Jabborovich**

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<http://orcid.org/0009-0005-5932-9841>**Abstract**

This study presents an assessment of the water-physical properties of rainfed soils. Enhancing the fertility of rainfed soils and developing scientifically sound agronomic practices for the efficient utilization of soil moisture under water-limited conditions necessitate a comprehensive investigation of their water-physical characteristics. Key indicators governing the soil water regime include particle-size distribution, soil aggregate structure, total porosity, and soil organic matter (humus) content. These properties play a crucial role in regulating water storage, retention, and transport within the soil profile, thereby significantly affecting crop productivity, resource-use efficiency, and the long-term sustainability of agroecosystems in regions characterized by inadequate precipitation.

Keywords: rainfed soils, soil texture, soil water-physical properties, soil aggregate structure, organic matter content, total porosity.

The water-physical properties of soils are of great importance, especially in the conditions of current climate change, it is important to study the water-physical properties of loamy soils. In order to increase the fertility of loamy soils and apply various agrotechnical measures to them in conditions of water scarcity, it is necessary to study the water-physical properties of soils in depth. The water-physical properties of the soil depend on its granulometric composition, aggregation, porosity and humus content, which determine the efficiency of irrigation and farming.

In his studies conducted between 1938 and 1942, B.V. Gorbunov was among the first researchers to describe the chemical and physical properties of sierozem soils in the rainfed agricultural zone according to the soil-geomorphological regions identified for the foothill areas of the Turkistan Mountain Range. At the same time, to determine and compare the changes occurring in sierozem soils under rainfed farming conditions, he carried out investigations in areas where uncultivated land and cultivated lands were located in close proximity to each other.

In his research, the author provided a comprehensive description of the genetic characteristics, morphology, chemical composition, hydrophysical properties, humus and nutrient contents, moisture regime, transformations of loess involved in the formation of light sierozem, typical, dark, and washed sierozem soils, as well as uncultivated land soils. He also extensively explained the causes of compaction in the middle part of the soil profile and the processes associated with the genesis and evolution of sierozem soils [2, 3].

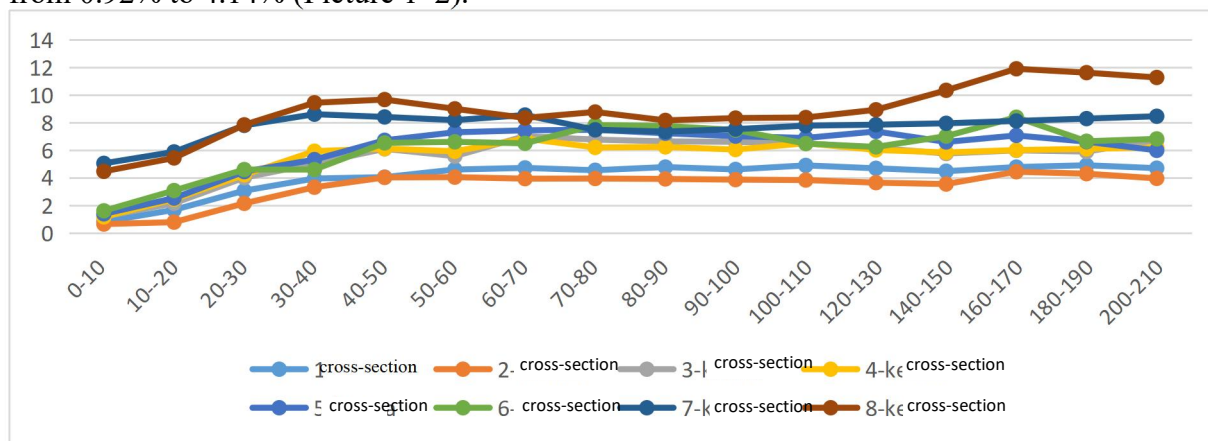
The properties of irrigated and rainfed soils distributed across Uzbekistan have been studied by various scientists over different periods, with the majority of investigations conducted during the 1960s and 1970s. A.Z. Genusov, B.V. Gorbunov, and N.V. Kimberg not only described the processes of soil formation and differentiation but also developed soil classification systems. The hydrophysical properties of rainfed soils were partially discussed in the book published by M.U. Umarov in 1974 [1;4;5;6;7;8].

The soil moisture content of rainfed soils varies depending on vegetation cover, the amount of precipitation received throughout the year, and the overall properties of the soil. In rainfed soils, precipitation serves as the primary source of water and plays a key role in the formation of

soil water reserves. In this study, soil moisture content was investigated, and its temporal and spatial variations were monitored and analyzed (Picture 1–2).

According to the studies of B.V. Gorbunov, the moisture content in the upper turf and sub-turf layers (0–50 cm) of Profile 1 (virgin light sierozem soil) ranged from 0.82% to 4.05%. In our study, the moisture content in the corresponding upper turf and sub-turf layers (0–50 cm) of Profile 1 (virgin light sierozem soil) was found to range from 0.92% to 4.14% (Figures 1–2).

According to the studies conducted by B.V. Gorbunov, the moisture content in the upper turf and sub-turf horizons (0–50 cm) of Profile 1, representing uncultivated land light sierozem soil, ranged from 0.82% to 4.05%. In our study, the moisture content in the corresponding upper turf and sub-turf horizons (0–50 cm) of Profile 1 of uncultivated land light sierozem soil ranged from 0.92% to 4.14% (Picture 1–2).

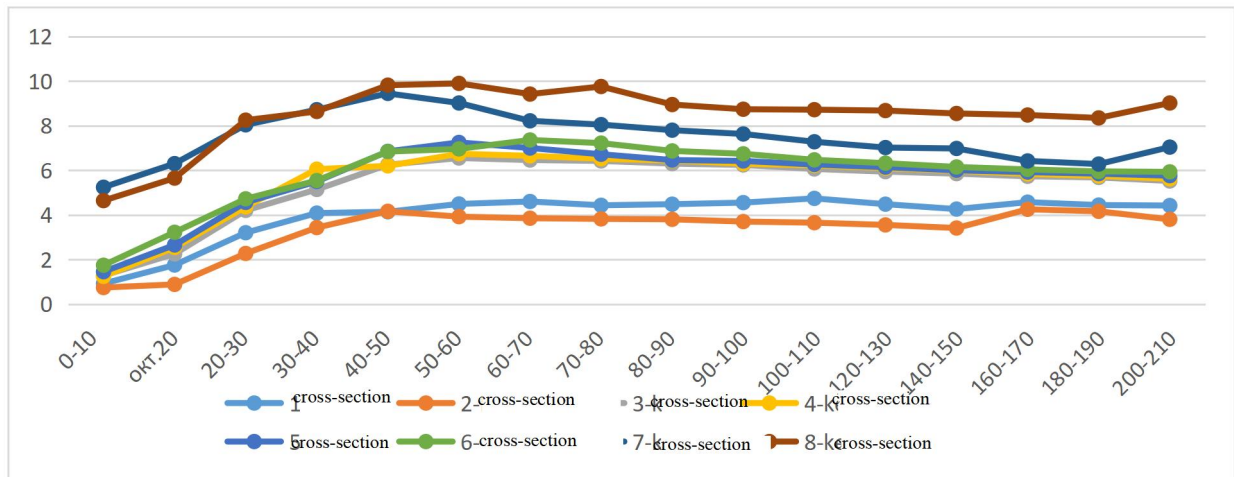


Picture-1. Soil Moisture Content of Rainfed Soils (Based on Data by B.V. Gorbunov, 1938–1940)

According to the data by B.V. Gorbunov (1938–1940), the moisture content in the ploughed and sub-ploughed layers (0–50 cm) of Profile 2 of uncultivated land light sierozem soil ranged from 0.65% to 4.03%. In our study, the moisture content in the corresponding ploughed and sub-ploughed layers (0–50 cm) of Profile 2 of uncultivated land light sierozem soil ranged from 0.74% to 4.16% (Picture 1–2).

According to the data by B.V. Gorbunov (1938–1940), the moisture content in the upper turf and sub-turf layers (0–50 cm) of Profile 4 of uncultivated land typical sierozem soil ranged from 1.17% to 6.12%. In our study, the moisture content in the corresponding upper turf and sub-turf layers (0–50 cm) of Profile 4 of uncultivated land typical sierozem soil ranged from 1.24% to 6.20% (Picture 1–2).

According to the data by B.V. Gorbunov (1938–1940), the moisture content in the ploughed and sub-ploughed layers (0–50 cm) of Profile 5 of uncultivated land dark sierozem soil ranged from 1.39% to 6.72%. In our study, the moisture content in the corresponding ploughed and sub-ploughed layers (0–50 cm) of Profile 5 of uncultivated land dark sierozem soil ranged from 1.45% to 6.85% (Pictures 1–2).



Picture-2. Moisture content of rainfed soils (data by D.J. Mamaraimov, 2022–2024)

According to the data by B.V. Gorbunov (1938–1940), the moisture content in the upper turf and sub-turf layers (0–50 cm) of Profile 6 of uncultivated land dark sierozem soil ranged from 1.61% to 6.53%. In our study, the moisture content in the corresponding upper turf and sub-turf layers (0–50 cm) of Profile 6 of uncultivated land dark sierozem soil ranged from 1.74% to 6.84% (Picture 1–2).

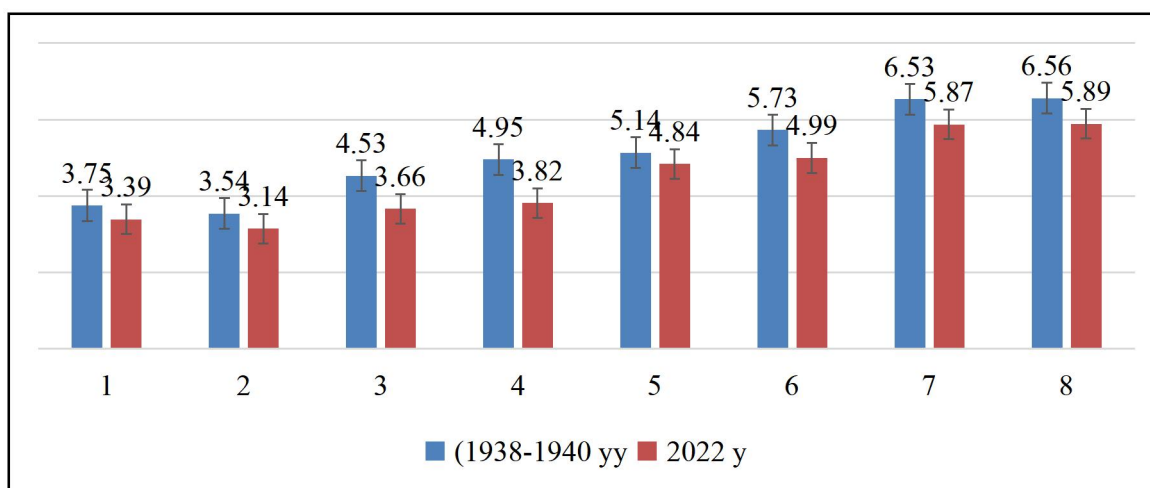
According to the data by B.V. Gorbunov (1938–1940), the moisture content in the upper turf and sub-turf layers (0–50 cm) of Profile 7 of leached uncultivated land dark sierozem soil ranged from 5.05% to 8.41%. In our study, the moisture content in the corresponding upper turf and sub-turf layers (0–50 cm) of Profile 7 of leached uncultivated land dark sierozem soil ranged from 5.24% to 9.45% (Picture 1–2).

According to the data by B.V. Gorbunov (1938–1940), the moisture content in the ploughed and sub-ploughed layers (0–50 cm) of Profile 8 of leached rainfed dark sierozem soil ranged from 4.47% to 9.67%. In our study, the moisture content in the corresponding ploughed and sub-ploughed layers (0–50 cm) of Profile 8 of leached rainfed dark sierozem soil ranged from 4.64% to 9.82% (Picture 1–2).

At higher elevations above sea level, soil types gradually change, accompanied by variations in climate and precipitation patterns, which in turn affect soil moisture dynamics. As noted above, B.V. Gorbunov's studies demonstrated an increase in soil moisture content from the upper horizons toward the lower layers. In contrast, our study revealed relatively higher moisture content in the upper and middle horizons, with a decreasing trend toward the lower layers.

The differences observed in our study may be explained by the decreased precipitation in recent years, reduced snowfall, insufficient infiltration of moisture into deeper soil horizons, climate change, and elevated temperature conditions. These factors are considered to have significantly influenced the soil moisture regime (Figures 1–2).

In recent years, we consider the results of our research to be evidence of the low amount of precipitation, reduced snowfall, insufficient penetration of moisture into deeper soil layers, climate change, and high temperatures (Picture 1–2).



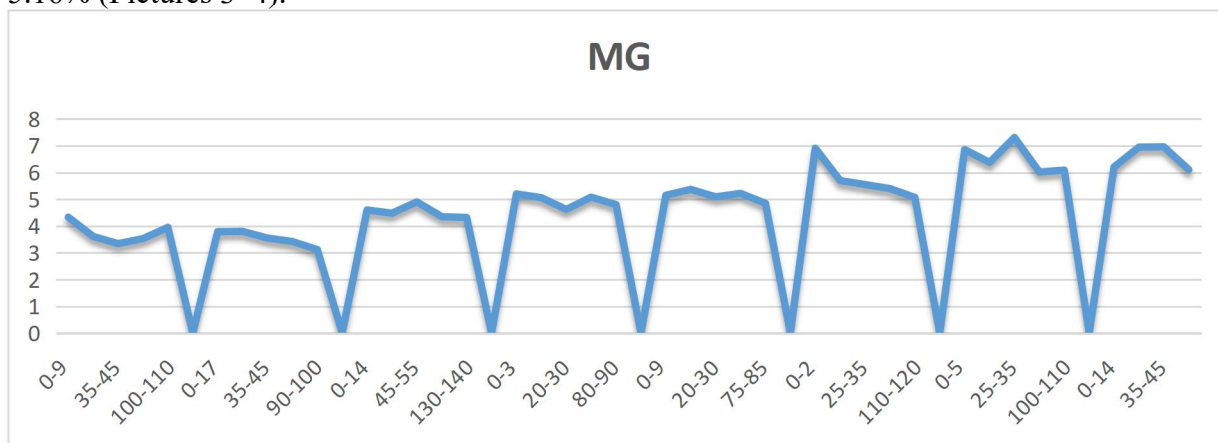
Picture-3. Maximum hygroscopicity of rainfed land soils, %. Note: the numbers indicate sections

The maximum hygroscopic moisture (MH) of soils depends on their mechanical composition, sorption capacity, mineralogical composition, and organic matter content. The obtained data show that in the studies of B.V. Gorbunov, in uncultivated land light sierozem soils (cross-section 1), the values in the upper turf and sub-turf layers ranged from 3.61–4.33%, whereas in our study of uncultivated land light sierozem soils (cross-section 1), these values ranged from 3.03–4.20% in the same layers (Picture 3–4).

In the plough layer and sub-plough layer of the second profile of rainfed light sierozem soils, the humus content was reported to be 3.79–3.80% in 1938–1940 according to B.V. Gorbunov. In our study, the humus content in the same soil profile ranged from 3.14 to 3.44% (Picture 3–4).

In the plough layer and sub-plough layer of the third profile of rainfed typical sierozem soils, the humus content was reported to be 4.46–4.60% in 1938–1940 according to B.V. Gorbunov. In our study, the humus content in the same soil profile ranged from 3.92 to 3.99% (Figures 3–4).

In the plough layer and sub-plough layer of the fourth profile of uncultivated land typical sierozem soils, the humus content was reported to be 5.06–5.20% in 1938–1940 according to B.V. Gorbunov. In our study, the humus content in the same soil profile ranged from 3.44 to 5.16% (Pictures 3–4).



Picture-4. Maximum hygroscopicity indicators of rainfed soils (data by B.V. Gorbunov, 1938–1940)

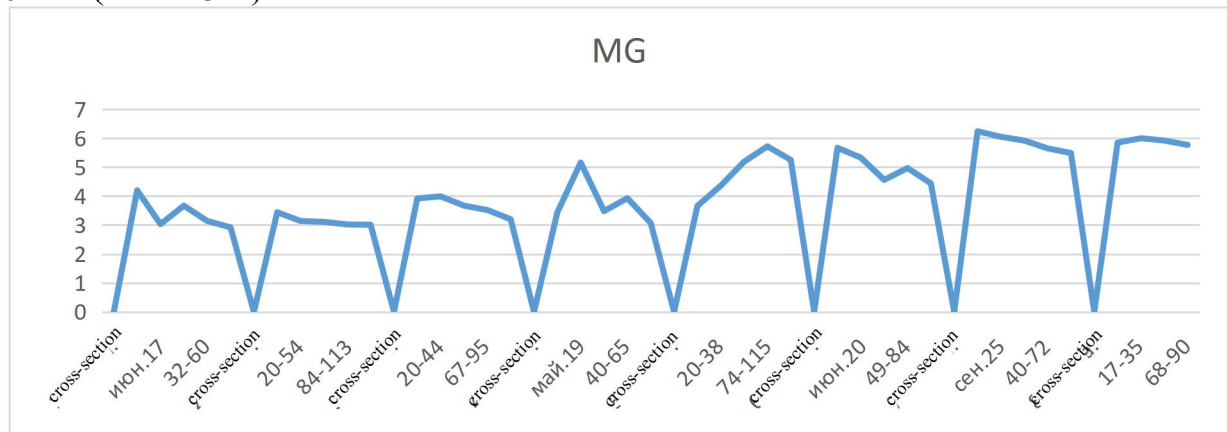
In the plough layer and sub-plough layer of the fifth profile of rainfed dark sierozem soils, the humus content was reported to be 5.15–5.37% in 1938–1940 according to B.V. Gorbunov. In our study, the humus content in the same soil profile ranged from 3.66 to 4.36% (Picture 3–4).

According to B.V. Gorbunov's data (1938–1940), the moisture content in the plow and sub-plow layers of Profile 6 dark sierozem soils ranged from 5.70% to 6.91%. In our study, the

moisture content in the plow and sub-plow layers of Profile 6 dark sierozem soils ranged from 5.33% to 5.67% (Figures 3–4).

In the plough layer and sub-plough layer of the sixth profile of uncultivated land dark sierozem soils, the humus content was reported to be 5.70–6.91% in 1938–1940 according to B.V. Gorbunov. In our study, the humus content in the same soil profile ranged from 5.33 to 5.67% (Picture 3–4).

In the plough layer and sub-plough layer of the seventh profile of leached virgin dark sierozem soils, the humus content was reported to be 6.38–6.86% in 1938–1940 according to B.V. Gorbunov. In our study, the humus content in the same soil profile ranged from 6.05 to 6.24% (Picture 3–4).



Picture-5. Maximum hygroscopicity indicators of rainfed soils (data by J.D. Mamaraimov, 2022–2024)

In the plough layer and sub-plough layer of the eighth profile of leached rainfed dark sierozem soils, the humus content was reported to be 6.21–6.95% in 1938–1940 according to B.V. Gorbunov. In our study, the humus content in the same soil profile ranged from 5.85 to 6.00% (Picture 3–4).

In B.V. Gorbunov's studies, a higher maximum hygroscopic moisture content in soils was observed, whereas in our study the maximum hygroscopic moisture content was found to be relatively lower. This can be attributed to climate change and alterations in the mineralogical and chemical composition of soils (Picture 3–4).

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