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СОДЕРЖАНИЕ

БИОЛОГИЧЕСКИЕ НАУКИ

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CHARACTERISTICS AND EVOLUTION OF IRRIGATED SOILS OF GIJDUVAN DISTRICT OF BUKHARA REGION

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Abstract. This study examines the classification, mechanical composition, and salinity dynamics of irrigated soils in the Gijduvan district of the Bukhara region. The assessment of soil evolution and its implications for sustainable land use remains a crucial scientific endeavor. The research provides detailed insights into the characteristics of soils utilized for irrigated agriculture in the region, emphasizing their transformation over time. A key focus of the study is the alteration in the mechanical composition of these soils over an 11-year period. Comparative analysis reveals that, by 2022, the proportion of soils with heavy and medium loamy textures had expanded, whereas the extent of soils with lighter loamy and sandy loam textures had diminished relative to 2011. Furthermore, the study presents a comprehensive evaluation of saline soil distribution in 1984, 2011, and 2022. The findings indicate a notable increase in non-saline areas alongside a reduction in slightly saline soils over the years. However, the average extent of saline soils in 2022 was observed to be higher than in previous years.

The study also quantifies the total area and degree of soil salinity in the region as of 2022. Moreover, a detailed analysis was conducted on soil samples collected in the current year, categorized based on their mechanical composition. Field and laboratory investigations adhered to standardized methodologies widely accepted in soil science. Representative soil types were identified, and excavation plots were established to facilitate systematic sampling. Each soil layer was subjected to laboratory analysis to determine its physical and chemical properties.

The concluding section of the article synthesizes the findings related to the primary types of irrigated soils in the region, the temporal variations in their salinity and mechanical composition, and the underlying factors contributing to these changes. Ultimately, the study provides a comprehensive evaluation of the evolutionary trends in irrigated soils within the Gijduvan district, offering valuable insights for agricultural management and soil conservation strategies.

Key words: soil characteristics, evolution of soils, irrigated soils, meadow soils, meadow-takyr soils, gray-brown-meadow soils, mechanical composition, saline soils, Gijduvan district, Bukhara region.

ХАРАКТЕРИСТИКА И ЭВОЛЮЦИЯ ОРОШАЕМЫХ ПОЧВ ГИЖДУВАНСКОГО РАЙОНА БУХАРСКОЙ ОБЛАСТИ

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Аннотация. В этом исследовании рассматриваются классификация, механический состав и динамика засоления орошаемых почв в Гиждуванском районе Бухарской области. Оценка эволюции почв и ее последствий для устойчивого землепользования остается важнейшей научной задачей. Исследование

дает подробное представление о характеристиках почв, используемых для орошаемого земледелия в регионе, подчеркивая их трансформацию с течением времени.
Ключевым объектом исследования является изменение механического состава этих почв за 11-летний период. Сравнительный анализ показывает, что к 2022 году доля почв с тяжелой и среднесуглинистой структурой увеличилась, в то время как доля почв с более легкой суглинистой и супесчаной структурой уменьшилась по сравнению с 2011 годом. Кроме того, в исследовании представлена всесторонняя оценка распространения засоленных почв в 1984, 2011 и 2022 годах. Полученные данные указывают на заметное увеличение площади незасоленных территорий при одновременном сокращении площади слабозасоленных почв за последние годы. Однако было отмечено, что средняя степень засоления почв в 2022 году была выше, чем в предыдущие годы.
В исследовании также дается количественная оценка общей площади и степени засоления почв в регионе по состоянию на 2022 год. Кроме того, был проведен подробный анализ образцов почвы, собранных в текущем году, которые были классифицированы в зависимости от их механического состава. Полевые и лабораторные исследования проводились в соответствии со стандартизированными методологиями, широко принятыми в почвоведении. Были определены репрезентативные типы почв и определены участки раскопок для облегчения систематического отбора проб. Каждый слой почвы был подвергнут лабораторному анализу для определения его физических и химических свойств.
В заключительном разделе статьи обобщаются данные, относящиеся к основным типам орошаемых почв в регионе, временным колебаниям их засоленности и механического состава, а также основным факторам, способствующим этим изменениям. В конечном счете, исследование дает всестороннюю оценку тенденций развития орошаемых почв в Гиждуванском районе, предлагая ценную информацию для управления сельским хозяйством и стратегий сохранения почв.
Ключевые слова: почвенные характеристики, эволюция почв, орошаемые почвы, луговые почвы, лугово-такырные почвы, серо-коричнево-луговые почвы, механический состав, засоленные почвы, Гиждуванский район, Бухарская область.

The process of soil evolution can be categorized into three distinct stages: the initial stage spanning from 1870 to 1920, the second phase from 1920 to 1960, and the ongoing third stage, which extends from 1960 to the present day [1, 2, 3].

Soil evolution refers to the long-term transformation of soil-forming factors, influenced by physical and geographical conditions, ultimately leading to a state of equilibrium [4, 5, 6]. This concept encompasses both theoretical and practical aspects, as it examines the progressive alterations in soil properties and characteristics over time. The pioneering work of soil scientist V.V. Dokuchaev emphasized the significance of a natural-historical perspective in understanding soil evolution. According to his definition, time and soil age are among the most critical factors in soil formation.

As a fundamental theoretical issue in soil science, soil evolution results in continuous modifications of soil properties and characteristics. The study of these changes includes aspects such as morphological variations due to climatic influences, anthropogenic activities, and their implications for soil classification and effective utilization. Addressing these aspects is essential for advancing the scientific understanding of soil dynamics and optimizing land management practices [7, 8, 9].

Numerous researchers have investigated soil evolution under the influence of diverse soil-climatic conditions, as well as natural and anthropogenic factors. Their findings confirm that this remains one of the most pressing issues in soil science, garnering significant interest from both natural and social sciences. The study of soil evolution holds not only theoretical value but also substantial scientific and practical significance [10, 11, 12].

A group of scientists has examined the transformations occurring in irrigated soils due to various natural and anthropogenic influences. Their research highlights the necessity of developing innovative scientific methodologies, enhancing soil fertility, and implementing management strategies based on soil properties and characteristics, all of which are critical challenges in the field [13, 14, 15].

For many years, scientific studies have been conducted to analyze the properties, characteristics, mechanical composition, and varying degrees of salinity in irrigated meadow, hard-meadow, and gray-brown-meadow soils within the Gijduvan district of the Bukhara region. These studies aim to assess soil conservation measures, improve fertility, and optimize land use efficiency. Investigating the impact of different anthropogenic factors on the development of irrigated soils in this region is of paramount scientific and practical importance. Furthermore, formulating scientifically grounded recommendations for the sustainable enhancement of soil fertility is crucial for ensuring long-term agricultural productivity.

The Gijduvan district, situated in the northeastern part of the Bukhara region, was officially established on September 29, 1926. The district encompasses a total land area of 384,068 hectares, with 27,007 hectares allocated for agricultural use, of which 19,994 hectares consist of irrigated lands. Geographically, it shares borders with Konimeh and Karmana districts of the Navoi region to the northeast, Vobkent district to the south, and Shafirkon district to the west [16, 17].

The Bukhara region is located within an arid desert zone, where irrigation is constrained by the scarcity of local water resources. Additionally, its position in the lower delta of the Zarafshan River results in the accumulation of soluble salts and chemical compounds transported via wastewater and collector-drainage systems. These dissolved substances ultimately concentrate in central collectors and artificial reservoirs such as Mokhonkol Lake.

According to 2019 data, the total irrigated land area in the district is 19,994 hectares, of which 10,041 hectares are affected by salinity to some degree. Specifically, 2,485.4 hectares exhibit moderate salinity, while 582.7 hectares are classified as highly saline. The predominant soil type in the region consists of ancient irrigated meadow soils, which have undergone long-term irrigation and cultivation. As a result, these soils contain higher humus content compared to non-irrigated soils.

In terms of mechanical composition, the soils range from light to medium and heavy loams. Notably, in the lower part of the district, the mechanical composition tends to become heavier due to continuous agricultural activities. Similarly, soils located adjacent to canals and irrigation ditches exhibit increased density, as fine soil particles transported by irrigation water gradually accumulate in these areas. Furthermore, among the ancient irrigated meadow soils, variations in salinity levels are observed, reflecting the complex interplay of hydrological and soil-forming processes in the region.

The investigation of mechanical composition, salinity levels, and the physicochemical properties of irrigated soils in the Gijduvan district of the Bukhara region is of significant scientific and practical relevance. This research focuses on long-term changes in soil conditions under the influence of various anthropogenic factors, emphasizing their efficient utilization, the enhancement of agricultural productivity, and the sustainable management of soil resources.

Field and laboratory experiments were conducted on ancient irrigated meadow, bald meadow, and gray-brown meadow soils characteristic of the Gijduvan district. The study was carried out in field, laboratory, and office settings, following widely accepted soil science methodologies.

A combination of geographical, genetic, and historical comparative methods, along with lithological-geomorphological, chemical-analytical, and profile-based approaches, was employed. Laboratory analyses were conducted using established methodological guidelines, including "Methods of Agrochemical, Agrophysical, and Microbiological Studies in Irrigated Cotton Areas," "Methods of Agrophysical Studies of Central Asian Soils," and "Methods for Studying the Physical Properties and Composition of Soils."

For this research, soil samples were collected from agricultural lands with meadow, hard-meadow, and gray-brown-meadow soils, covering different sections and spatial distributions within the region. The morphological characteristics of the selected soil profiles were systematically examined. Additionally, laboratory analyses were performed to assess their composition and physicochemical properties, providing insights into soil evolution, fertility management, and sustainable agricultural practices.

In 2020, the total irrigated agricultural land area in the Gijduvan district was 19,994 hectares. The distribution of soil types within this area was as follows:

Meadow soils covered 10,556.2 hectares, constituting 52.8% of the total irrigated land.

Steppe-meadow soils accounted for 5,478.4 hectares, making up 27.4% of the total area.

Barren-meadow soils occupied 2,739.2 hectares, representing 13.7% of the total irrigated land.

Gray-brown soils covered 3.3%, while gray-brown-meadow soils comprised 2.8% of the total area (Figure 1).

These findings provide insights into the spatial distribution of irrigated soil types in the district, highlighting the predominance of meadow and steppe-meadow soils in agricultural land use.

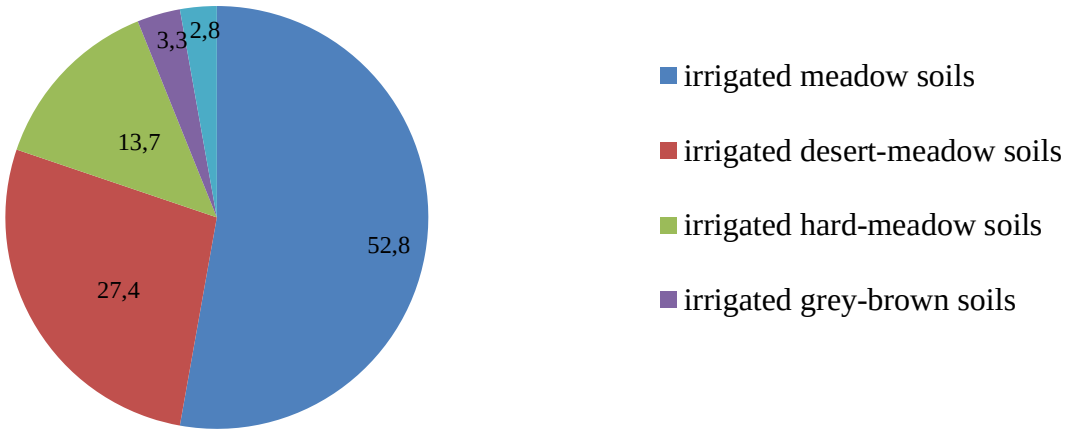

Fig. 1. Types of irrigated soils of Gijduvan district, %
(data from the Scientific Research Institute of Soil Science and Agrochemistry, 2020)

The primary irrigated soil types in the district include meadow, desert-meadow, and hard-meadow soils. This study examines the changes in the mechanical composition of irrigated soils in the district over an 11-year period (2011–2022), focusing on the impact of anthropogenic factors on soil texture dynamics.

According to the findings, in both 2011 and 2022, heavily textured soils (loamy soils) accounted for 0.1% of the total land area. However, the proportion of heavy loamy soils increased significantly, rising from 9.5% in 2011 to 20.1% in 2022. Similarly, the extent of medium loamy soils showed an upward trend, increasing from 52.6% in 2011 to 60.4% in 2022. These results indicate that the mechanical composition of the district's irrigated soils has progressively shifted towards heavier textures over the past 11 years, suggesting an ongoing transformation influenced by agricultural practices, irrigation methods, and land use patterns (Fig. 2).

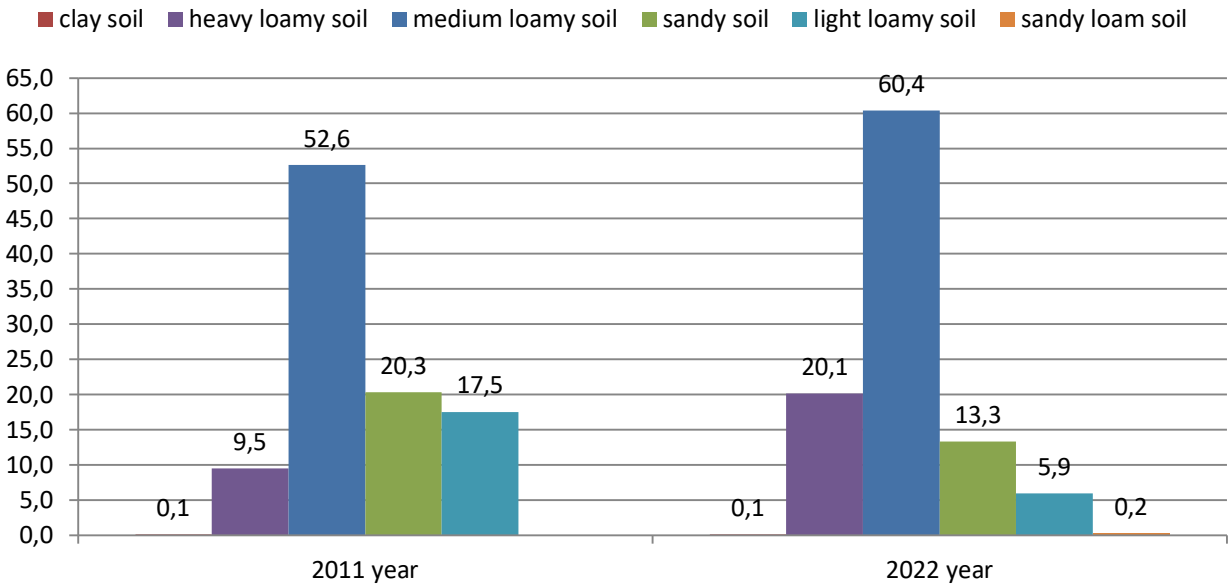

Fig. 2. Mechanical composition of irrigated soils of Gijduvan district

A comprehensive assessment of soil salinity levels in the irrigated agricultural lands of Gijduvan district was conducted for the years 1984, 2011, and 2022. The findings indicate notable temporal changes in salinity distribution across the region.

According to the analysis, the proportion of non-saline soils increased from 15.2% in 1984 to 19.4% in 2022, suggesting an improvement in soil conditions. Conversely, the share of saline areas excluding settlements exhibited a declining trend, decreasing from 73.7% in 1984 to 59.6% in 2011, and further to 58.4% in 2022.

Furthermore, the average saline area expanded slightly over time, rising from 11.1% in 1984 to 12.3% in 2022. However, a significant reduction was observed in the extent of highly saline soils, which declined from 7.0% in 2011 to 2.1% in 2022. Similarly, the proportion of severely saline soils decreased from 2.5% in 2011 to 1.2% in 2022 (Fig. 3).

These findings underscore the dynamic nature of soil salinity trends in the region, reflecting the combined influence of irrigation practices, land management strategies, and environmental factors on soil salinity evolution over time.

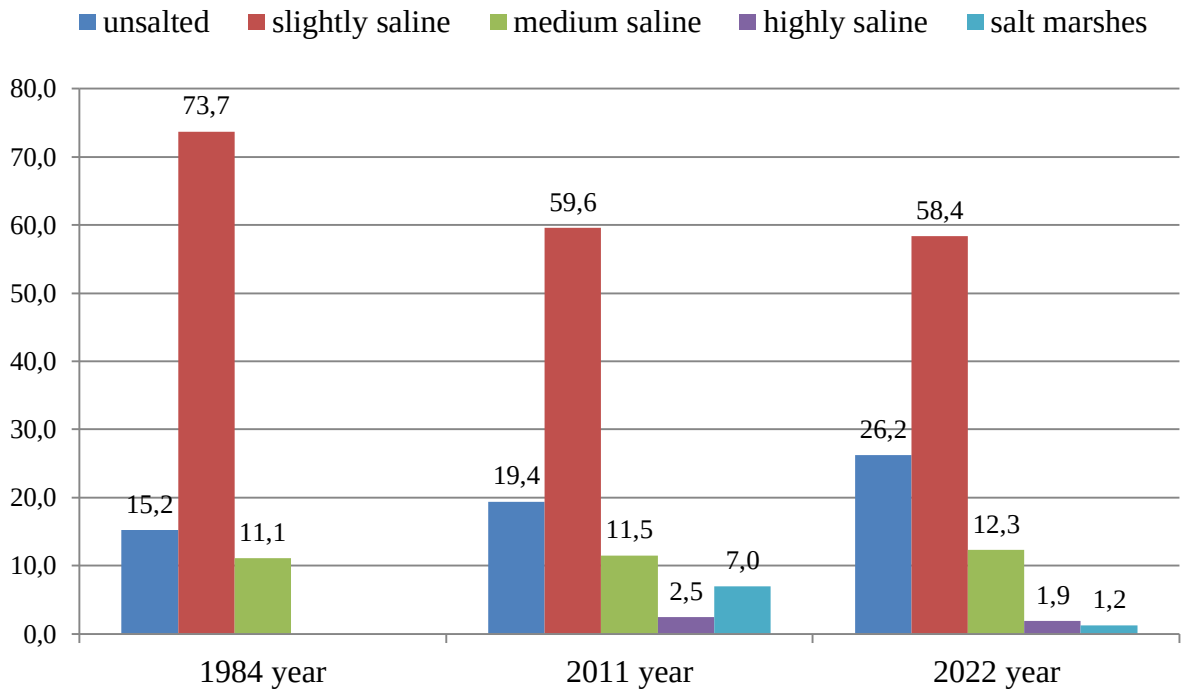

Fig. 3. Change in the salinity level of irrigated soils of the district by year

Over an extended period (1984–2022), insufficient adherence to irrigation norms, proportions, and methods in the irrigated agricultural lands of the region has contributed to a progressive increase in soil salinity.

As of the most recent assessment, the total irrigated land area in Gijduvan district amounts to 19,994 hectares, with the following distribution of salinity levels:

Non-saline soils constitute 26.2% of the total area (5,239.4 hectares).

Weakly saline soils account for 58.4% (11,676.5 hectares).

Moderately saline soils make up 12.3% (2,459.3 hectares).

Strongly saline soils cover 1.9% (379.9 hectares).

Severely saline soils represent 1.19% of the area (239.9 hectares).

These findings (Fig. 4) highlight the persistent challenges in managing soil salinity in the region, emphasizing the necessity for sustainable irrigation practices and improved soil management strategies to mitigate further salinization.

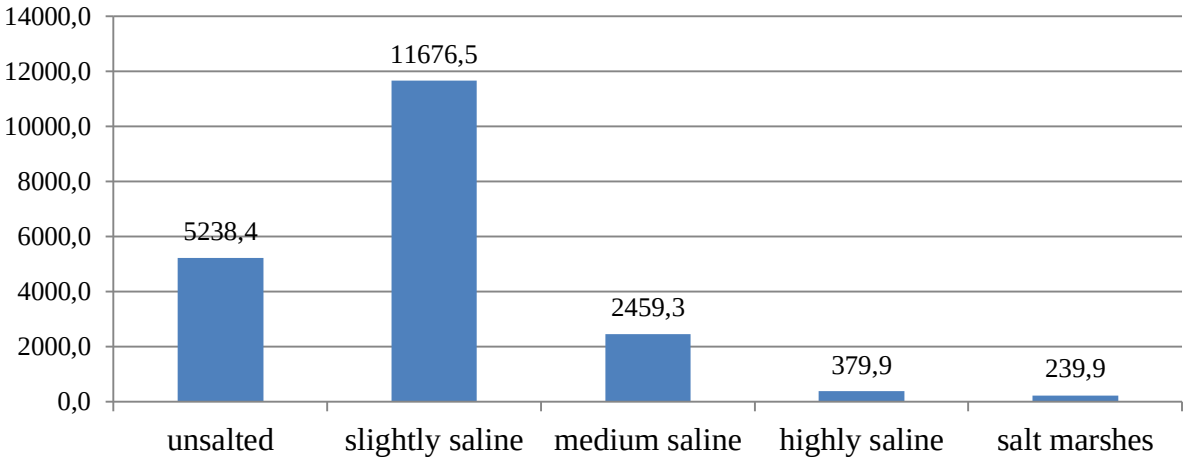

Fig. 4. The area of irrigated soils by salinity (data compiled by the author, 2022)

The majority of irrigated agricultural soils in the district are classified as non-saline or weakly affected by salinization, while moderately saline, strongly saline, and highly saline soils occupy only a small fraction of the total area.

An analysis of the mechanical composition of these soils indicates the following distribution:

Loamy soils cover 21.1 hectares.

Heavy loamy soils extend over 4,021.1 hectares.

Medium loamy soils dominate the region with 12,070.1 hectares.

Light loamy soils occupy 2,660 hectares.

Sandy soils account for 1,188.4 hectares.

Sandy loam soils are the least prevalent, covering only 33.3 hectares.

Overall, the mechanical composition of irrigated soils in the district is primarily dominated by heavy and medium loamy textures, while light loamy, sandy loamy, and sandy soils represent a minor proportion of the total area (Fig. 5). These findings emphasize the prevailing soil texture trends in the region, which play a crucial role in irrigation efficiency, water retention capacity, and agricultural productivity.

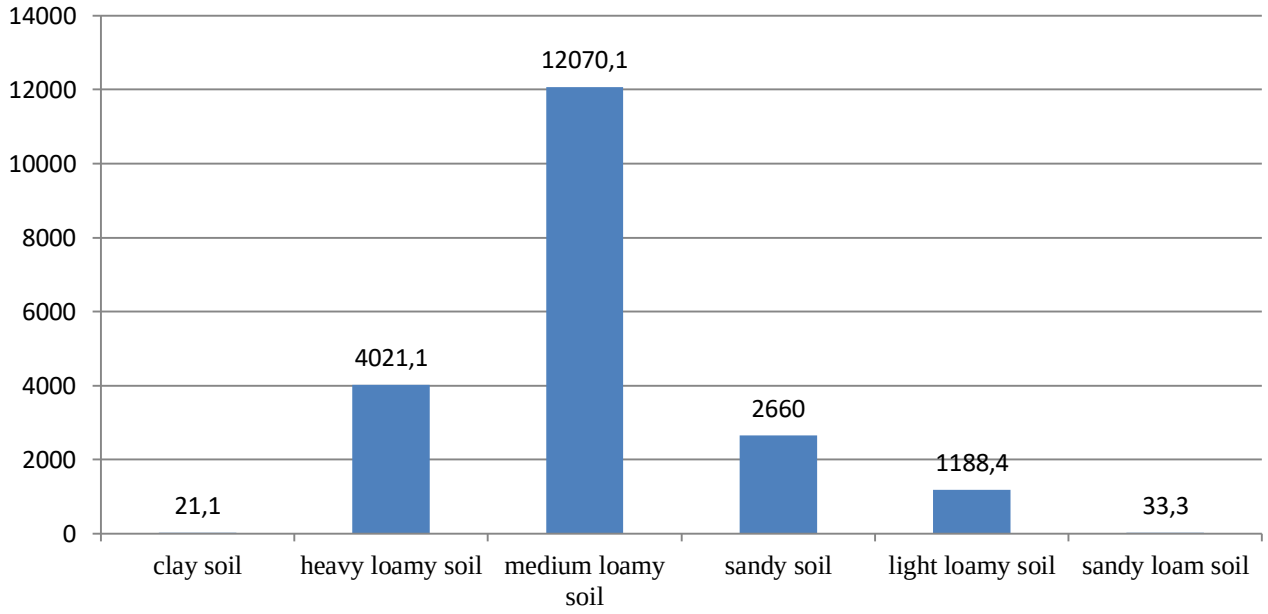

Fig. 5. The area of irrigated soils according to mechanical composition (data compiled by the author, 2022)

The majority (52.8%) of the irrigated soils in the Gijduvan district of the Bukhara region consist of irrigated meadow soils. Over the years, the mechanical composition of these soils has undergone significant changes due to the impact of various anthropogenic factors.

According to the analysis, the proportion of loamy soils remained relatively stable at 0.1% of the total area in both 2011 and 2022. However, the share of heavy loamy soils increased notably from 9.5% in 2011 to 20.1% in 2022. Similarly, medium loamy soils expanded from 52.6% in 2011 to 60.4% in 2022, indicating a progressive increase in soil density over the past 11 years.

In terms of soil salinity, the proportion of saline lands excluding settlements declined from 73.7% in 1984 to 59.6% in 2011, and further to 58.4% by 2022. However, the average saline area increased from 11.1% in 1984 to 12.3% in 2022. Meanwhile, the extent of saline soils decreased from 7.0% in 2011 to 2.1% in 2022, and the severely saline areas were reduced from 2.5% in 2011 to 1.2% in 2022.

A detailed mechanical composition analysis of the region's irrigated soils revealed the following distribution:

Loamy soils: 21.1 hectares

Heavy loamy soils: 4,021.1 hectares

Medium loamy soils: 12,070.1 hectares

Light loamy soils: 2,660 hectares

Sandy soils: 1,188.4 hectares

Sandy loam soils: 33.3 hectares

Given the observed trends in soil salinization, it is crucial to implement appropriate agrotechnical measures to improve land reclamation conditions and mitigate the spread of salinity. Enhancing irrigation management strategies and adopting sustainable soil conservation practices will be essential in ensuring the long-term productivity and sustainability of agricultural lands in the district.

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