THE ROLE OF KEY AGROECOLOGICAL FACTORS IN THE FORMATION OF DESERT SOIL FERTILITY

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Abstract. This article analyzes the primary agroecological factors that determine soil fertility based on a review of scientific literature. It highlights the physical, chemical, and biological properties of soil, as well as the effects of organic matter, pH, nutrient elements, moisture, and salinity on fertility. Special attention is given to the agroecological state of irrigated soils in the Fergana Valley.

Keywords: soil fertility, agroecological factors, irrigated soil, humus, pH, trace elements, salinization.

Introduction. Soil fertility is a critical natural factor that ensures the growth, development, and productivity of agricultural crops; its formation is governed by the interplay of physical, chemical, and biological processes. When evaluating fertility, alongside nutrient elements, it is essential to take a comprehensive account of soil structure, organic matter content, pH, moisture regime, and biological activity [6].

One of the primary indicators of soil fertility is the content of organic matter and humus. They play a vital role in nutrient cycling, soil aggregate formation, moisture retention, and microbiological processes [7]. Soil pH is an important chemical factor that influences the mobility and plant bioavailability of nutrients [8]. The concentration and mobile forms of macro- and micronutrients are critical for characterizing the agroecological condition of soils; in the irrigated soils of the Fergana Valley, their geochemical characteristics have been shown to correlate directly with regional environmental conditions [5].

Soil physical properties—specifically structure, aggregate stability, porosity, and the air-water regime—are likewise crucial determinants of fertility. Soil structure is directly linked to water permeability, aeration, and root development [9, 10].

Under the conditions of the Fergana Valley, irrigation, salinization, and anthropogenic pressures play a decisive role in altering soil fertility. Intensified salinization, biogeochemical changes, shifts in physicochemical properties, and anthropogenic degradation processes have all been documented in these irrigated soils [2, 4]. Agronomic practices aimed at efficient irrigation, moisture management, and salinity mitigation are vital for preserving soil fertility [1].

A review of the literature demonstrates that soil fertility forms through an interconnected complex of organic matter, pH, nutrients, physical-structural status, moisture regime, biological activity, irrigation practices, and anthropogenic impacts. In the Fergana Valley, a comprehensive assessment of these factors serves as an essential scientific foundation for sustaining soil fertility and mitigating degradation processes.

Object and Methods of Research. The object of this research consists of the irrigated soils of the Fergana Valley and their agroecological characteristics. Key indicators determining soil fertility—organic matter, pH, macro- and micronutrients, structure, moisture, and salinization—were analyzed. The study employed scientific literature review, comparative analysis, synthesis, and systematization methods. Data regarding irrigation, salinization, and physicochemical properties of Fergana Valley soils were evaluated based on sources [1–5], while general agroecological factors governing soil fertility were assessed using scientific literature [6–10].

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Results. The literature review revealed that factors shaping soil fertility comprise an interconnected complex of physical, chemical, and biological processes. Among these, soil organic matter, pH, nutrient elements, structural condition, moisture regime, and biological activity were identified as core agroecological indicators [6–10].

Soil organic matter serves as a primary indicator of fertility, with its levels closely tied to aggregate stability, water-holding capacity, nutrient cycling, and microbial activity. A decline in organic matter can lead to a deterioration in physical and biological soil functions [7]. Concurrently, soil reaction (pH) represents a critical chemical determinant that controls the solubility, mobility, and plant uptake of nutrients [8].

The analyzed literature confirms that the physical state of the soil is an indispensable component of fertility. Specifically, soil structure, aggregate stability, and porosity regulate the air-water regime, root system development, and nutrient dynamics [9, 10]. Therefore, when evaluating soil fertility, physical parameters must be considered alongside chemical and biological metrics.

Under Fergana Valley conditions, irrigation acts as a primary anthropogenic driver influencing soil fertility. Studies show that irrigation induces noticeable shifts in the physicochemical properties, salt regime, and biogeochemical state of the soil [2, 3]. In Central Fergana, anthropogenically driven transformations in irrigated soils—notably secondary salinization and accelerated degradation—have been documented [4]. These processes directly impair soil water-physical properties and nutrient availability, determining the overall agroecological status.

Data on irrigated soils in southern Fergana indicate that the geochemical distribution of trace elements is also crucial for evaluating soil fertility and ecological health [5]. In this context, accounting for both total concentrations and mobile (bioavailable) forms of macro- and micronutrients is vital for evaluating crop mineral nutrition.

Furthermore, agrotechnical measures focused on improving irrigation efficiency, maintaining optimal soil moisture, and suppressing secondary salinization play an essential role in sustaining fertility [1]. In summary, the fertility of irrigated soils in the Fergana Valley is governed not by a single parameter, but by the combined status of organic matter, pH, nutrients, soil structure, water-salt dynamics, and biological activity. Consequently, managing soil fertility requires assessing these indicators in conjunction and optimizing irrigation regimes alongside anthropogenic pressure.

Conclusion. The literature review demonstrates that soil fertility is governed by the dynamic interaction of organic matter, pH, nutrient elements, physical-structural condition, moisture, and biological activity. In the Fergana Valley, irrigation regimes, salinization, and anthropogenic factors substantially drive changes across these parameters. Preserving and enhancing soil fertility therefore necessitates a comprehensive assessment of physical, chemical, and biological indicators, complemented by the implementation of efficient irrigation practices and sound agrotechnical management.

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