







SEASONAL DYNAMIC STUDY OF SOIL COVER AND PLANT PRODUCTIVITY IN PASTURES IN THE KHACHMAZ, NEFTCHALA AND LANKARAN-ASTARA REGIONS

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ABSTRACT

To protect and rationally use pastures, a seasonal assessment of their productivity and justification for temporary use are necessary. Our research has shown that pasture productivity varies significantly depending on the grazing season and the degree of degradation. For the first time in Azerbaijan, the full seasonal dynamics of pasture vegetation and soil parameters (agrochemical, agrophysical, and landscape characteristics) across various phytocenoses were studied using innovative methods. An analysis of the dynamics of seasonal productivity over the past three years showed that the average annual productivity of semi-desert vegetation across various formations is 15.6 s/ha (fresh mass) and 10.4 s/ha (dry mass).

Keywords: Vegetation diversity, Productivity, Ecological assessment, Phytocenoses, Climate, Geological parameters.

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1. INTRODUCTION

To ensure food security for the population of Azerbaijan, it is important to develop scientific and practical foundations for protecting natural forage vegetation, effectively using and improving biodiversity, including phytodiversity, and preventing degradation processes (Akbarova & Mammadova, 2024). In accordance with the objectives set out in the Action Plan for the implementation of the State Program, as well as the plan and program of the dissertation work, ecological-geobotanical or phytocenological studies were carried out on pastures and rangelands of the Neftchala, Siyazan, Khachmaz, Lankaran and Astara regions of the Caspian coast (in the autumn, winter and spring seasons of 2023-2025). Anthropogenic activity in this area has made significant adjustments to the dynamics of the vegetation cover, its species composition and productivity: the area of eroded and degraded pastures has increased sharply, the grazing load has increased, and the forage capacity and quality of forage have decreased (Akhundova et al., 2025; Ali et al., 2025; Alakbar et al., 2026). The Khachmaz region belongs to the warm, humid subtropical climate zone with mild winters and a long growing season. The agroclimatic conditions of the Lankaran region during the typical study period are characterized by a humid subtropical climate, sufficiently warm vegetation and high humidity, which is favorable for subtropical and high-yield crops (citrus fruits, tea, nuts, grapes, etc.). The agroclimatic conditions of the Neftchala region in the typical study period are characterized by a semi-desert, dry climate with a pronounced temperature contrast and relatively low precipitation, which predetermines the specifics of agricultural land use. These alarming trends necessitated a deep analysis in the condition of arid pastures, identifying the causes of their degradation, and developing effective measures for their improvement, protection, and sustainable use, taking into account the characteristics of the main soil types and moisture availability. Coastal vegetation is closely linked to the natural features of the regions, and its evolutionary patterns are determined by soil characteristics (Bunyatova et al., 2025; Ahmad et al., 2026; Ali et al., 2026). The subsequent evolution of vegetation is closely linked to the terrain and corresponds to changes in absolute altitude. This complex evolution of the vegetation cover of the study area, involving vegetation from neighboring regions, has determined the

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significant species, phytocoenotic, and resource diversity of the phytocoenoses. Currently, the largest families play a significant role in the flora of this region (*Chenopodiaceae*, *Compositae*, *Graminaceae*, *Leguminosae*, *Polygonaceae*, *Borraginaceae*, *Liliaceae*, *Zygophyllaceae*, *Alismaceae*, *Cariophyllaceae*, *Jnetaceae*, *Tamaricaceae*, *Plumbaginaceae*, *Serohubariaceae*) (Ismayil et al., 2025; Gahramanova et al., 2026; Gurbanov et al., 2026; Huseynova et al., 2026). They account for 90% of the total number of species and genera. When characterizing pastures, the composition of forage species and their productivity are the basis. However, for targeted environmental assessments of the condition of pastures and other types, we use the more comprehensive concept of "ecosystem," which is considered the unity of biota and habitat (Ibrahimova et al., 2024; Ismayilova et al., 2025a; Ismayilova et al., 2025b).

For the first time in Azerbaijan, an ecological assessment of soils with vegetation in the *Artemisieta*, *Petrosimonium*, *Salsoletum-Artemisiosum*, and *Paliurussetum-Sambutcetum-Cynodosum* formations was conducted based on soil fertility parameters. Below are some examples of natural vegetation loss on gray, saline, gray-brown, and yellow-podzolic soils of winter and suburban pastures within the study administrative regions. Bush and tree species: *Astracantha* spec., *Acer laetum*, *Acer platanoides* L., *Berberis vulgaris* L., *Betula litwinowii*, *Betula raddeana*, *Cotoneaster melanocarpus*, *Muricaria germanica* L., *Cotinus coggyria*, *Carpinus betulus*, *Cornus mas* L., *Corpus sanguinera* subsp., *Crataegus germanica* L., *Daphne glomerata*, *Juniperus communis* subsp., *Juniperus excelsa* subsp., *Lisgustrum vulgare* L., *Fagus orientalis*, *Quercus iberica*, *Quercus macranthera*, *Papulus euphratica*, *Euonymus verrucosa*, *Eleagnus rhamnoides* L., *Juglans regia* L., *Alnus incana* L., *Clematis orientalis*, *Populus alba* L., *Primula veris* subsp., *Pyrus salicifolia* Pall., *Pyrus georgia* Kuth., *Pyrus communis* subsp., *Prunus spinosa* L., *Onobrychis cornuta* L., *Salix caprea* L., *Spiraea hypericifolia* L., *Stachys byzantina*, *Viburnum lantana* L., and others. Herbaceous species: *Acillea seracea*, *Alchemilla sericata*, *Allium kunthianum*, *Arenaria serpyllifolia* L., *Astragalus sanguinolentus*, *Astrantia trifida*, *Aconitum nauseum* Fisch., *Agrimonia eupatoria*, *Alyssum alyssoides* L., *Artemisia absinthium* L., *Artemisia chamaemelifoliya*, *Brachypodium sylvaticum*, *Briza minor* L., *Bromopsis ramosa*, *Brachypodium pinnatum* L., *Bupleurum falcatum*, *Carex bumilis* Leyss., *Carlina vulgaris* L., *Campanula rapunculoides* L., *Campanula collina*, *Centaurea phrygia*, *Cephalaria velutina*, *Cirsium macrocephalum*, *Cirsium obvallatum*, *Cruciata glabra* L., *Cruciata laevipes*, *Diantbus fragrans*, *Diantbus caucaseus*, *Festuca ovina*, *Festuca stricta*, *Festuca woronowii*, *Fragaria viridis*, *Fritillaria collina*, *Filipendula vulgaris*, *Filipendula ulmaria*, *Galium anfractum*, *Galium valantoides*, *Galium boreale* L., *Gentianella amarella* L., *Gentiana septemfida*, *Geranium ruprechtii*, *Geranium sanguineum* L., *Galega orientalis*, *Kalidium caspicum*, *Salsola verrucosa*, *Lucium rutbenicum*, *Inula orientalis*, *Leontodon bispidus*, *Medicago glomerato*, *Medicago lupulina* L., *Partinaca armena*, *Plantago media* L., *Potentilla reptans* L., *Sesleria phleoides*, *Stachus macrantha*, *Thymus caucasicus*, *Urtica dioica*, *Origanum vulgare* L. and others (Mammadova et al., 2024a; Ibrahimova & Imanov, 2025; Khudaverdi et al., 2026; Macnunlu et al., 2025). Pasture productivity is quite high in the spring, so given the biological feasibility of grazing, all types of pastures can be used during this period, provided that phytomass management is managed sparingly. If 45–50% of the phytomass is utilized during this period, without grazing poor and very poor areas. Considering that the spring pasture period in the study region lasts 59 days, with an average daily feed requirement of 1.4 kg per sheep, this mass is sufficient to support 2.9 sheep on each of the listed pasture types for 59 days. This easily determines the total number of animals on the region's pastures during the spring (Mirzazadeh et al., 2025; Madnee et al., 2025). Pasture plants in summer are characterized by a relatively rich species composition, but lower productivity than in spring. During this period, the greatest deficit in available soil moisture occurs, increasing the likelihood of soil deflation and vegetation degradation. This requires a very precise assessment of grazing loads and a gentle land management regime, despite the highest projective cover during this period and the good productivity of all pasture types. During the summer, pasture productivity changes significantly (Huseynova et al., 2026). The area of rich pastures increases more than 20-fold, the area of medium- and poor-quality pastures increases 60-fold, and the area of poor-quality pastures increases almost 1.5-fold, while the area of poor and very poor pastures decreases. If the remaining mass (after spring grazing) were grazed on these same rich, medium, and poor pastures over the course of 90 days, this area could support 1.3 million sheep; each hectare would feed one sheep for three months. Since the summer pasture season is the longest (90 days), it is necessary to analyze not only pasture productivity but also the species status of the grass stand, which determines forage quality and the resilience of phytocenoses. Medium-sized pastures exhibit slight soil degradation and slight soil breakdown. Xerophytic subshrubs, associated with brown and gray-brown soils, predominate here, along with haloxerophytic subshrubs on saline soils. The productivity of these pastures is unstable, the plant species composition is limited, and the maximum amount of forage mass is formed mainly in spring or autumn. The soils are generally degraded. Such lands are used primarily selectively. Poor pastures occupy the largest area, accounting for 46.7% of the territory (Makki et al., 2025; Mammadova et al., 2025a; Mammadova et al., 2025b). The category of very poor pastures occupies 5.1% of the territory. All plant

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communities here are severely degraded. Bare soils predominate; the vegetation cover does not exceed 30% and is represented mainly by sparse marsh cinquefoil and sedge (Mammadzada et al., 2025). The pasture is severely degraded, and it cannot regenerate on its own. It should be noted that the summer pasture season has medium to low resource and grazing potential, and the pastures themselves pose a constant threat of desertification. The autumn pasture season is characterized by the absence of rich pastures and by deteriorating forage quality on other land types. During this period of the year, poor pastures predominate (Mammadova et al., 2026a; Mammadova et al., 2026b; Nasirova et al., 2026). One of the reasons for this pasture condition is the high proportion of poorly palatable plants, whose productivity is sharply reduced by litterfall. The predominance of these plants in the grass stands indicates a high degree of pasture degradation due to indiscriminate grazing.

2. MATERIALS AND METHODS

The data collection method utilized a 1 m x 1 m frame weight estimation method. The frame was systematically placed in the pasture, after which vegetation within the frame was cut and placed in plastic bags for immediate weighing. Sample plots were defined using quadrants, each quadrant measuring 1 m x 1 m (Fig. 1). The frame was randomly dropped within the observation area to determine the center point. From this center point, plots were systematically established in each of the four cardinal directions east, west, north, and south resulting in 25 plots in each direction (Nazim & Oqtay, 2024; Rzayeva et al., 2026). Within each plot, vegetation type, species distribution, and the frequency, density, and dominance of each species were recorded by counting vegetation in each plot. The study includes field measurements and observations, as well as GIS-based processing of both vector and raster data. The study collects primary and secondary data; primary data is obtained through direct field measurements, while secondary data is collected from literature and relevant institutions. The primary data collected focus on forage crop and vegetation production. Plant composition data were collected using direct measurement methods, including the sum dominance ratio (SDR) method. The data determine the botanical composition and average productivity of fresh and dry feed materials. The analysis was conducted using descriptive methods and multivariate analysis, principal component analysis (PCA), cluster mapping using R-Studio, and analysis of variance (ANOVA) to test for statistically significant differences in biomass, species abundance, and productivity between sampling directions, plot groups, and other categorical factors. Where ANOVA indicated significant effects, post-hoc pairwise comparisons (Tukey's HSD) were performed to identify which groups differed.

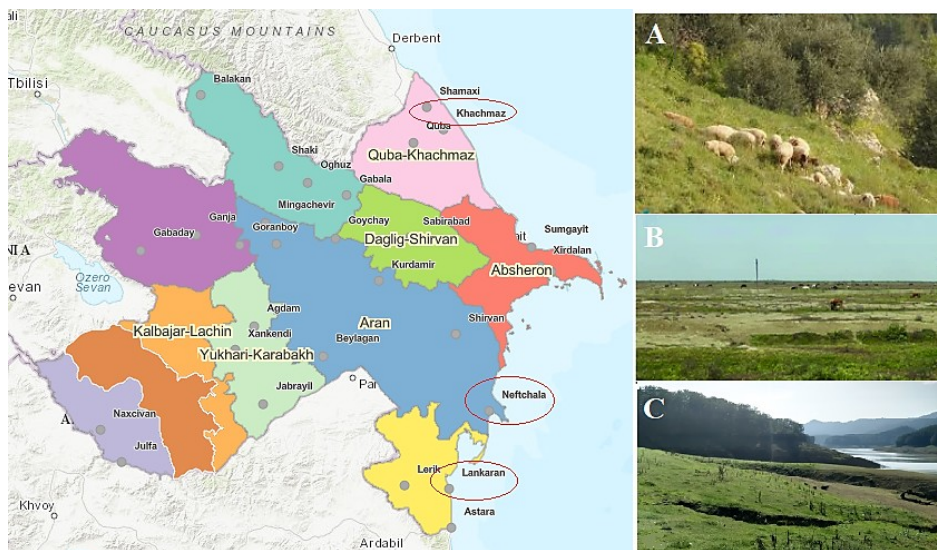


Fig. 1: Study areas: Khachmaz (A), Neftchala (B) and Lankaran (C) regions of Azerbaijan.

3. RESULTS

Overall, the average winter cereal productivity in 2023-2025 ranged from 12.3 to 8.9 s/ha in terms of wet matter and from 10.2 to 7.4 s/ha in terms of dry matter. The average annual wet and dry productivity over the three years was 10.3 s/ha and 8.6 s/ha, respectively. The edificant and monodominant species of the winter cereal group is the branched winter cereal (*Petrosimonia brachiata*), an annual halophyte plant and an indicator of saline soils (Shukurov et al., 2025). Livestock also poorly graze the plant after frosts, while the upper soil horizon where it grows is quite saline. The biochemical composition of the feed mixture included hygroscopic

moisture of 12.0%, crude ash of 5.8%, crude protein of 5.3%, crude fat of 2.6%, crude cellulose of 29.1%, and NFE of 45.2%. Based on the feed quality or nutritional value, 36.0 feed units and 2.3 digestible protein were determined in 100 kg of the winter pasture feed mixture. Based on these indicators, the feed units, dry matter yield, as well as the pasture use period (210 days), and the daily feeding rate of cattle 1.3 feed units), as well as the grazing load (1.1 heads per hectare) were determined. In autumn 2023, the productivity of the phytocenoses of *Salsolium-Artemisium* with botanical groups of cereals (in wet weight) on the studied suburban pasture (Khachmaz region) was 8.3 s/ha (44.2%); in winter - 5.4 s/ha (28.7%) of various cereals, and in spring - 3.2 s/ha (17.0%) of cereals and 1.9 s/ha (10.1%) of legumes. It should be added that, thanks to favorable climatic conditions and fertile soil, the productivity of the phytocenoses was high that year. The formation's productivity that year (in dry matter) was determined as 5.5 s/ha (44.0%) for various cereals in the fall, 3.6 s/ha (28.8%) for winter; 2.1 s/ha (16.8%) for grains; and 1.3 s/ha (10.4%) for legumes in the spring. The drying coefficient corresponds to 1.5. The productivity of the *Salsolium-Artemisium* formation in the fall of 2017 (by wet mass) was 5.8 s/ha (35.8%), in winter - 5.0 s/ha (30.9%) of various cereals, and in spring - 3.3 s/ha (20.4%) of cereals and 2.1 s/ha (12.9%) of legumes. In general, the main fruit-bearing and valuable forage plants in the *Salsolium-Artemisium* phytocenoses are *Salsola dendroides* and *Artemisia lercheana*, which are considered important forage plants.

In this regard, intensive grazing of livestock on the studied pastures leads to a thinning of their vegetation cover, deterioration and change in the species composition of the phytocenoses in the pastures, instead of the appearance of harmful and poisonous weeds, as well as to an increase in erosion processes and degradation of the corresponding ecosystem (Verdiyeva et al., 2025). An environmental assessment of natural forage lands in the coastal zone of the Caspian Sea can be used in land cadastre work, which is considered an important government measure. Therefore, based on the environmental assessment of pastures and meadows, it may be necessary to create, effectively use, and improve agrophytocenoses, as well as to implement and manage phytomelioration measures to enrich the forage base for livestock farming (large-egg cattle) in our country, increasing the productivity and quality of forage. Analysis of vegetation diversity (VD) in the Neftchala, Khachmaz and Lankaran regions reveals different patterns of species abundance in the dry and rainy seasons. VD based on dry and rainy seasons shown in Fig. 2 and 3.

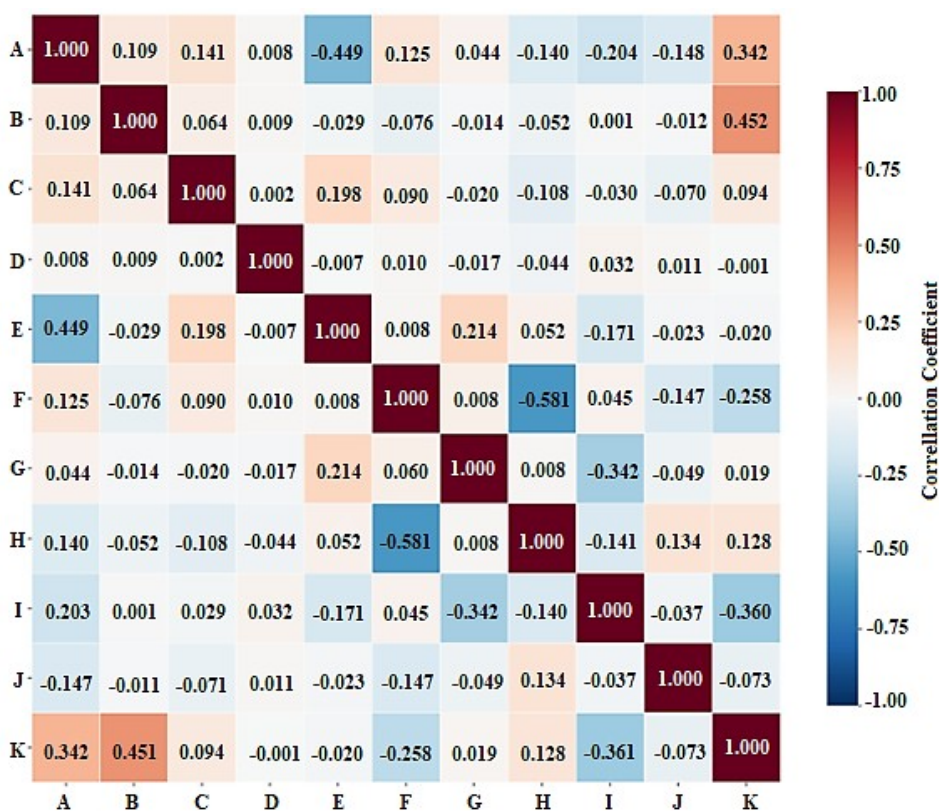


Fig. 2: Correlation between evaluation factors. Note: A – Slope; B – Distance to water; C – Rainfall; D - Profile curvature; E - Plane curvature; F – NDVI; G – Lithology; H – Land use type; I – Distance to fault; J – Elevation; K – Aspect.

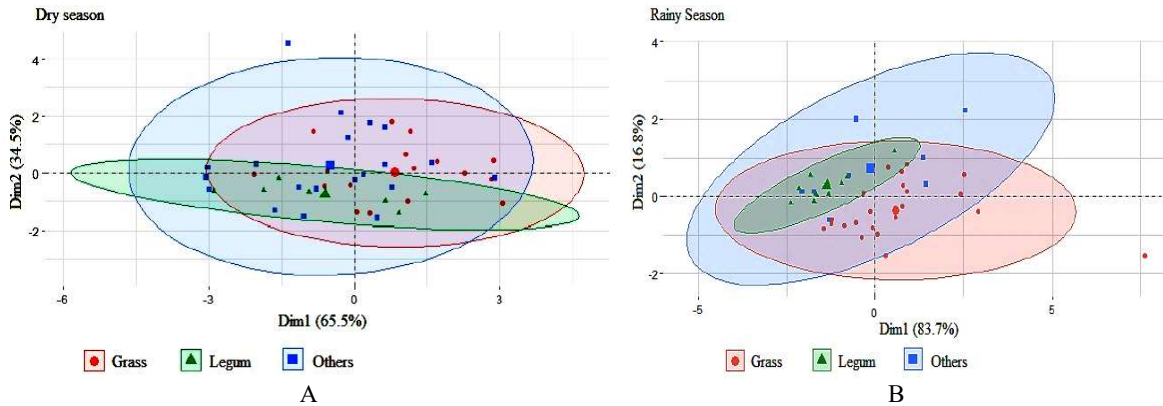


Fig. 3: Individuals PCA of forage diversity based on dry (A) and rainy season (B).

Dim1 (Primary Axis) Explaining 65.5% (and up to 83.7% in the rainy season) of the total variance, Dim1 represents the most vital differences in plant characteristics. Grass varieties (red circles) cluster heavily along this axis, indicating their dominant role and specific adaptations to the environment. Dim2 (Secondary Axis): Explaining 34.5% of the variance, this dimension further separates forage types. Legume varieties (green triangles) primarily group on the negative side of Dim2, showing they share distinct traits that set them apart from grasses and other plant groups (Fig. 3). Cereals, indicated by red circles, are mostly distributed along the axis, indicating trait diversity. Legume varieties, indicated by green triangles, are densely clustered around the origin of the graph. The vertical cluster illustrates the distribution patterns of various forage species, while the horizontal cluster displays the distribution of yield parameters, including FW, FWP, DW, and DWP (Fig. 4).

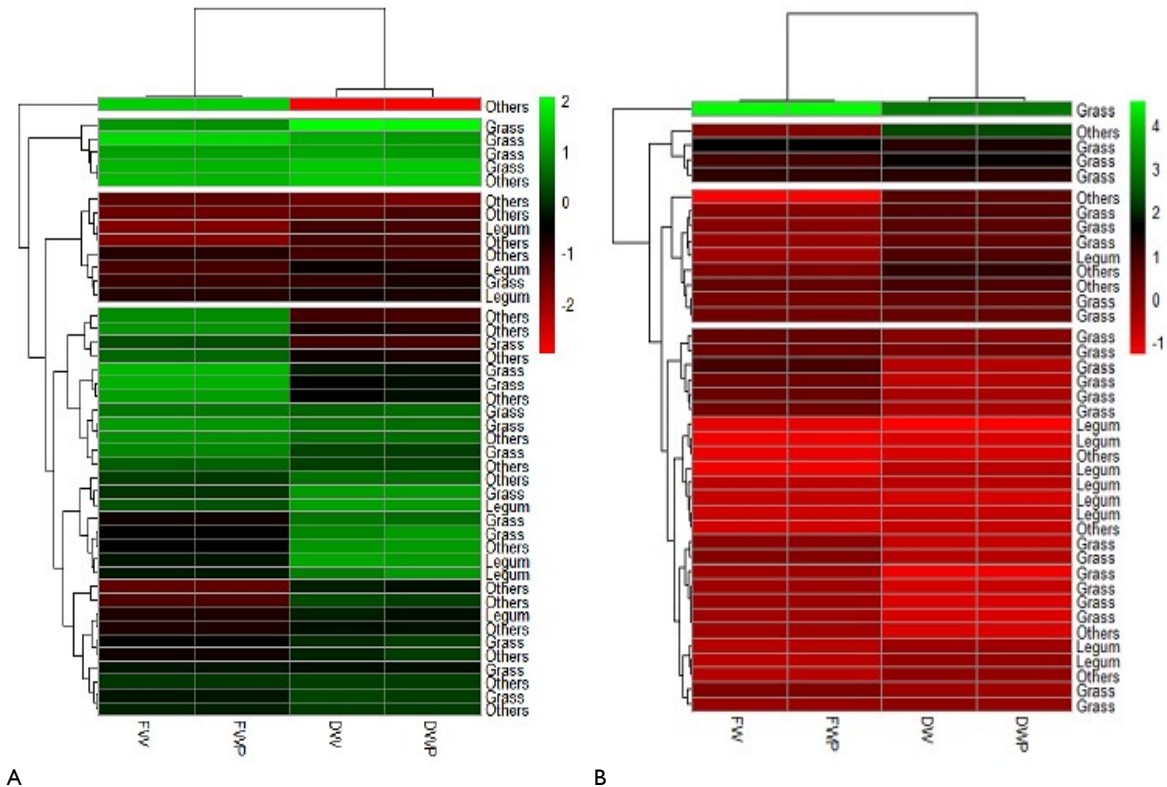


Fig. 4: Cluster map of forage diversity based on the dry (A) and rainy season (B). Note: FWP (fresh weight productivity); DW (dry weight); DWP (dry weight productivity); FW (fresh weight).

4. DISCUSSION

The vegetation cover of the wormwood formation is typical of the semi-desert type; its productivity was determined on a winter pasture in the Neftchala region, located in the southern part of the Caspian coast (Shukurov et al., 2025). In 2023, the air temperature in autumn was 10.5-21.9°C, and precipitation was 14-37 mm; in winter, the air temperature was 4.2-5.6°C, and precipitation was 24-28 mm. In spring, the air temperature increased by 3°C (13.1°C) compared to winter, and precipitation totaled 91 mm. The productivity of the wormwood phytocenoses was determined to be 7.8 centners/ha (39.6%) in wet weight in autumn, 6.0 centners/ha (30.4%) in winter, and 5.9 centners/ha (30.0%) in spring of various cereals and legumes (Nasirova, 2023a). The productivity of the formation (in dry matter) in the spring of the corresponding year was 2.3 s/ha (17.7%), grains and legumes - 1.59 s/ha (11.5%), the total productivity of both botanical groups was 3.8 s/ha (29.2%), various herbs in the fall - 5.2 s/ha (40.0%), and in winter - 4.0 s/ha (30.8%). The dynamics of average monthly and annual productivity in the phytocenoses ranged from 3.8–5.2 s/ha, and the aridity coefficient was 1.5. Changes in the productivity of this formation in 2024 are associated with precipitation and air temperature. In this regard, the average monthly temperature in the autumn season in the Neftchala region increased by 1.1°C (22.5-11.6°C), while precipitation decreased by 1.2 times (30-17 mm). Thus, the average monthly temperature in the winter season of that year was 6.1°C, and precipitation was 50 mm. In the summer months, the air temperature is 19.3°C, and precipitation reaches 72 mm. In autumn 2024, the productivity of the phytocenoses (in fresh mass) was 6.3 s/ha (42.6%), in winter - 4.7 s/ha (31.8%), and in spring - 3.8 s/ha (25.6%), while in spring (in dry mass) 1.6 s/ha (16.2%) of cereals, 1.0 s/ha (10.1%) of legumes and 4.2 s/ha (26.3%) of various cereals were determined (Nasirova, 2023b). The drying coefficient (decomposition of fresh mass into dry mass) is 1.4-1.5. As already mentioned, the productivity dynamics of this formation are dominated by botanical groups comprising various cereals. The average monthly air temperature in the Neftchala region in autumn 2025 was 19.3°C, 6.1°C in winter, and 16.2°C in spring. Average monthly precipitation is 66 mm in autumn, 45 mm in winter, and 60 mm in spring. In particular, the average annual precipitation in the study area reaches 202 mm. Therefore, the low precipitation in this region indicates the presence of desertification processes (in an arid zone). In autumn 2025, the productivity of the phytocenoses (in wet mass) was 5.2 s/ha (41.9%), in winter - 3.9 s/ha (31.5%) of various herbs, in spring - 2.1 s/ha (16.9%) of grains and 1.2 s/ha (9.7%) of legumes. In the same year, the productivity of the formation (in dry mass) in autumn was 3.5 s/ha (42.2%) of various herbs, in spring - 2.6 s/ha (31.3%) of grains and 0.8 s/ha (9.6%) of legumes (Mammadova et al., 2026b; Nasirova et al., 2026). The drying coefficient is 1.5. An analysis of the seasonal productivity dynamics over the past three years shows that the average annual productivity of the semi-desert vegetation was 15.6 s/ha (fresh weight) and 10.4 s/ha (dry weight). In this regard, it can be added that the productivity of the plant formation was approximately 1.5-1.2 times higher than that of the winter herbaceous phytocenoses of the desert type (10.3 s/ha fresh weight and 8.6 s/ha dry weight in winter herbaceous vegetation). An analysis of the biochemical parameters of the main forage plants common in the vegetation of the plant formation shows that the hygroscopic moisture is 13.0%, absolute dry matter is 6.6%, crude protein is 8.9%, crude fat is 2.7%, crude cellulose is 26.8%, and nitrogen-free extractives (NFE) is 42.0%. According to the feed quality (nutritional value) data of this farm, 44.2 feed units and 4.5 units of digestible protein were calculated per 100 kg of feed (Bunyatova et al., 2025). Thus, taking into account productivity (10.4 sec/ha), nutritional value (44.2 feed units per 100 kg of feed), pasture use period (210 days), and daily livestock feeding rate (1.3 feed units), the grazing load (carrying capacity per hectare) was determined to be 1.7 heads on winter pastures in the Neftchala region, which is considered the "object" of the study. Based on the productivity, feed units, and optimal use (grazing) rate of the plant formation, we conclude that the area of winter pastures where this phytocoenosis is widespread belongs to the medium-quality group or category. Therefore, it is advisable to implement measures to effectively utilize the phytodiversity of this formation. The annual productivity of the winter herbaceous formation is lower than that of the plant formation. Studies show that in the autumn of 2023, the productivity of the winter herbaceous phytocenoses (by wet mass) was 5.3 s/ha (43.0%), in winter 3.4 s/ha (27.6%) of various grasses, in spring 2.0 s/ha (16.3%) of cereals and 1.6 s/ha (13.0%) of legumes. In the autumn of the same year, the productivity (in dry mass) was 4.4 s/ha (43.1%), in winter 2.8 s/ha (27.4%) of various grasses; in spring 1.7 s/ha (16.7%) of cereals and 1.3 s/ha (12.8%) of legumes. The drying coefficient is 1.2. The productivity of this pasture (in 2017) was determined as 3.7 s/ha (37.7%) in the fall (in terms of wet matter), 3.0 s/ha (30.6%) in winter (in terms of various grasses); 1.8 s/ha (18.4%) in spring (in terms of cereals) and 1.3 s/ha (13.3%) in spring (in terms of legumes). Productivity indicators vary depending on the grazing season.

In particular, in the fall of 2024, the productivity of winter pasture formation (in terms of dry matter) was determined as 3.2 s/ha (39.0%), in winter (in terms of various grasses) 2.4 s/ha (29.3%), in spring (in terms of various grasses); In spring, the yield was 1.5 s/ha (18.3%) (Macnunlu et al., 2025) (in terms of cereals) and 1.1 s/ha (13.4%) (in terms of legumes). The drying coefficient is 1.2. In autumn 2025, the yield (winter herbaceous phytocenoses) was 3.4 s/ha (38.2%) in fresh weight for various cereals, 2.6 s/ha (29.2%) in winter; 1.9 s/ha (21.4%) for cereals and 1.0 s/ha (11.2%) for legumes in spring. In autumn of that year, the yield (in dry weight) of various

cereal crops decreased by approximately 1.1 times compared to autumn 2024, that is, from 3.2 s/ha to 2.8 s/ha; in winter, the yield of various cereals was 2.2 s/ha (29.8%); In spring - 1.6 s/ha (21.6%) for cereals and 0.8 s/ha (10.0%) for legumes. The drying coefficient is 1.2. Overall, the average winter cereal productivity in 2023-2025 ranged from 12.3 to 8.9 s/ha in terms of wet matter and from 10.2 to 7.4 s/ha in terms of dry matter. The average annual wet and dry productivity over the three years was 10.3 s/ha and 8.6 s/ha, respectively. The dominant and monodominant species of the winter cereal group is the branched winter cereal (*Petrosimonia brachiata*), an annual halophyte plant and an indicator of saline soils. Livestock also poorly graze the plant after frosts, while the upper soil horizon where it grows is quite saline. The biochemical composition of the winter pasture forage includes hygroscopic moisture (12.0%), crude ash (5.8%), crude protein (5.3%), crude fat (2.6%), crude cellulose (29.1%), and NFE (45.2%). Based on the quality or nutritional value of the feed, 36.0 feed units and 2.3 digestible protein were determined per 100 kg of winter pasture forage (Nazim & Oqtay, 2024; Rzayeva et al., 2026). Based on these indicators, the feed unit, dry matter yield, as well as the pasture use period (210 days), the daily feeding rate of cattle (smallmouths) (1.3 feed units), and the grazing load (1.1 heads per hectare) were determined. Based on the quality or nutritional value of the forage, 36.0 feed units and 2.3 digestible proteins were determined per 100 kg of winter pasture feed.

These indicators took into account the feed unit, dry matter productivity, the pasture use period (210 days), the daily feeding rate for cattle (1.3 feed units), and determined the grazing load (1.1 head per hectare). Therefore, the winter pasture productivity (8.6 s/ha in consumed mass), feed unit, and optimal grazing rate were classified as low-quality. The productivity of the *Salsolium-Artemisiosum* formation was determined on suburban pastures formed on saline gray-brown soils of the Khachmaz region in the Samur-Shabran lowland, located in the northern part of the Caspian coast. In autumn 2023 (September, October, and November), the air temperature fluctuated from 19.3 to 8.5 °C; the amount of precipitation was 33-37 mm. In winter, the average monthly air temperature was 4.2-1.6 °C, the amount of precipitation (velocity) was 79 mm; in spring, the air temperature was 10.6 °C, and the amount of precipitation varied within 80 mm. The productivity of the phytocenosis for groups of botanical cereals (in fresh weight) was 8.3 s / ha (44.2%); In winter, 5.4 s/ha (28.7%) were various cereals, and in spring 3.2 s/ha (17.0%) were cereals and 1.9 s/ha (10.1%) were legumes. The productivity of the phytocenoses was high that year, thanks to favorable climatic conditions and fertile soil. The productivity of the formation that year (in dry matter) was determined as 5.5 s/ha (44.0%) in autumn, 3.6 s/ha (28.8%) in winter; 2.1 s/ha (16.8%) for spring grains and 1.3 s/ha (10.4%) for legumes. The drying coefficient was 1.5. The productivity of the *Salsolium-Artemisiosum* phytocenoses in 2024 is related to air temperature and precipitation in the region. In this regard, the average monthly air temperature in autumn was 14.0°C, and precipitation was 78 mm. In the winter season of this year, the average monthly air temperature was 14.8°C, and precipitation was 49 mm. The average monthly air temperature in spring was 10.8°C (1.4 times lower than in winter), and precipitation reached 63 mm. The productivity of the *Salsolium-Artemisiosum* formation in autumn 2017 (by wet mass) was 5.8 s/ha (35.8%), in winter – 5.0 s/ha (30.9%) for various cereals, and in spring – 3.3 s/ha (20.4%) for cereals and 2.1 s/ha (12.9%) for legumes. In autumn of the same year (in dry matter), various cereals made up 3.9 s/ha (36.1%), in winter - 3.3 s/ha (30.5%); in spring, cereals - 2.2 s/ha (20.4%), and legumes - 1.4 s/ha (13.0%). The drying coefficient is 1.5. In the territory of the Siyazan region (in autumn 2025), the average monthly air temperature is 14.8°C, the amount of precipitation is 93 mm; in winter the air temperature is 15.9°C, the amount of precipitation is 92 mm, and in spring the air temperature is 16.9°C, and the average monthly precipitation is 88 mm (Verdiyeva et al., 2025; Ali et al., 2026). In autumn 2025, the productivity (in fresh mass) of the *Salsolium-Artemisiosum* phytocenoses was 5.3 s/ha (36.3%), in winter - 4.6 s/ha (31.5%) of various grasses; in spring - 2.9 s/ha (19.9%) of grains and 1.8 s/ha (12.3%) of legumes. In autumn 2025, the productivity in dry mass of this stand was 3.5 s/ha (37.1%), in winter - 2.9 s/ha (29.9%) of various grasses; in spring - 1.9 s/ha (19.6%) of grains and 1.4 s/ha (14.4%) of legumes (a total of 3.3 s/ha or 34.0%). The drying coefficient is 1.5. *Salsola dendroides* and *Artemisia lercheana*, which are considered the main woody plants and valuable forage plants in the *Salsolium-Artemisiosum* phytocenoses, have important forage value (Ibrahimova & Imanov, 2025; Khudaverdi et al., 2026). The dynamics of seasonal productivity of this formation over three years shows that the average annual productivity in fresh matter was 18.8 s/ha in 2023, 16.2 s/ha in 2024 and 14.6 s/ha in 2025 (an average of 16.5 s/ha over the years) (Mammadova et al., 2026b; Gahramanova et al., 2026). In accordance with the relevant indicators, in dry matter the following were determined: 12.5 s/ha, 10.8 s/ha, 9.7 s/ha (11.0 s/ha over the years). The biochemical composition of the phytocenoses in the *Salsolium-Artemisiosum* formation includes hygroscopic moisture of 12.4%, crude ash in absolute dry matter of 7.4%, crude protein of 10.0%, crude fat of 3.1%, and crude cellulose of 25.2% and NFE of 41.9%. In autumn 2025, the productivity (in the winter period of the herbaceous phytocenoses) was 3.4 s./ha (38.2%) in terms of fresh weight for various cereals, 2.6 s./ha (29.2%) in the winter months; 1.9 s./ha (21.4%) for grain crops and 1.0 s./ha (11.2%) in the summer months. In autumn of the same year, the productivity of various cereals (in dry weight) decreased by approximately 1.1 times compared to autumn 2024, i.e. from 3.2 s./ha to 2.8 s./ha; in winter, the

productivity of various cereals was 2.2 s./ha (29.8%); in spring - 1.6 s./ha (21.6%) for grain crops and 0.8 s./ha (10.0%) for legumes. The drying coefficient is 1.2.

5. CONCLUSION

Phytomelioration of the winter pasture (on saline soils) is recommended. *Salsolium-Artemisiosum* outperforms winter herbaceous pastures, offering better forage potential amid arid trends; sustainable management, such as optimized grazing, is essential to combat degradation on these saline coastal lands. Phytocenoses in Neftchala averaged 10.4 s/ha dry weight annually (2023-2025), classifying as medium-quality with a carrying capacity of 1.7 heads/ha over 210 days. Winter herbaceous types averaged 8.6 s/ha dry, low-quality, with 1.1 heads/ha, dominated by the saline indicator *Petrosimonia brachiata*. *Salsolium-Artemisiosum* in Khachmaz-Siyazan reached 11.0 s/ha dry, highest due to favorable soils, with key forages like *Salsola dendroides*. Grasses dominate (65.5% variance in the dry season, 83.7% in the rainy season), highlighting their primary role in trait diversity and yield parameters such as fresh weight (FW), dry weight (DW), and related productivity (FWP, DWP). Legumes cluster distinctly, especially on the negative side (34.5% dry-season variance) or near the origin under rainy conditions, signaling unique ecological niches relative to grasses. These groupings underscore grasses' broader adaptability to arid forage production, while legumes offer specialized contributions; targeted seasonal management could optimize compositions to enhance overall pasture resilience and productivity.

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