Grass ecosystems in agrolandscapes of the Yeletsky District of the Central Russian Province forest-steppe zone of the Central Chernozem Region of Russia

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Abstract. In order to study the spatial distribution of biological and ecological patterns of grass ecosystems, we conducted an agrolandscape-ecological zoning of the territory of the Central Chernozem Region of Russia (CCR) on the basis of the author's methodology. According to the zoning data, it is established that 75% of the territory of the CCR belongs to the forest-steppe zone. The Central Russian province of the forest-steppe zone covers 67% of the territory of the CCR. Yeletsky district occupies the eastern spurs of the Central Russian upland. The area of the district is 1929.7 thousand hectares. Most of the district (90%) is located in the Lipetsk region, 10% – in the Kursk region. In the past, the watersheds of the district were occupied by meadow steppes and partly oak forests. Currently, more than 80% of the district's territory is occupied by agricultural land (arable land, pastures, hayfields). The structure of land is dominated by arable land -67% of the total area of the district, pastures occupy 11%, hayfields – 3%, forests – 7%, shrubs – 2%, under water and swamps – 1%, other land – 8%. The grass ecosystems of the meadow steppes preserved along the gullies and slopes are mainly used as natural grasslands (NG) and make up 79% of all NG of the Yelets District. The most common are the downed tipchak pastures on the slopes of different steepness. The yield of these pastures is 8–12 centners per hectare of dry eaten mass.

Keywords: Central Chernozem region, unbalanced agricultural landscapes, soil fertility

1. Introduction

Land resources are a means of production in agriculture, a source of food and other resources, as well as the basis for the existence of the biosphere and the sustainable development of human civilization.
Ecology and rational use of natural resources are moral topics. The earth is our national treasure, for which we are responsible to the present and future generations of humanity on our planet.

Food and environmental security are closely interrelated and are a national priority for the State and society. They are the necessary foundation for the social well-being, economic development and independence of our country. We need a constructive compromise between ecology and economy, the activation of environmental protection activities and the development of environmental education.

Degradation processes are the main cause of modern agricultural environmental problems in Russia. They reduce the yield of agricultural crops, the stability of agroecosystems, and increase the cost of agricultural production. A significant role in the strengthening of erosion processes is played by the orientation of agricultural production on grain and row crops, monocultures and pure pairs. They expose the soil in time and space, weaken the soil protection and anti-erosion properties of agroecosystems [1–4].

Russia has accumulated a lot of environmental problems. At the same time, we have accumulated significant positive experience in solving them. We have huge opportunities to use the grass ecosystems of arable and pasture lands in Russia as accumulators of atmospheric carbon.

The process of carbon sequestration is an integral part of the photosynthesis of green autotrophic plants, which themselves, by converting carbon dioxide CO2, produce the organic substances necessary for themselves [3–6].

The study of perennial grasses and grass ecosystems is an important state task. In agriculture, agrolandscapes, and the biosphere, their significance and functions are very significant. They ensure the accumulation of solar energy and the accumulation of biomass in the biosphere and agricultural landscapes, the accumulation of carbon and the accumulation of humus, the diversity and biodiversity of ecosystems, their flora and fauna. They have great resistance to the external environment, climate change and weather.

2. Materials and Methods
In order to study the spatial distribution of biological and ecological patterns of grass ecosystems on the territory of the Central Chernozem Region of Russia (CCR), we conducted an agrolandscape-ecological zoning of the region using different information sources on the basis of the author's methodology [7–10].

The article is the result of many years of interdisciplinary research. It is based both on the data obtained by the authors as a result of agro-landscape-ecological zoning, in the course of field research, and on the analysis of remote data, statistical information, literary and stock sources.

3. Results and Discussion
According to the zoning data, it is established that the majority (75%) of the territory of the CCR belongs to the forest-steppe zone. The Central Russian province of the forest-steppe zone covers the main part of the territory of the CCR and occupies 11245.0 thousand hectares, or 67% of its area. The western part of the province is located in the central part of the Central Russian upland, while the eastern part occupies the Oka-Don Plain.

The province is dominated by meadow steppes and meadow-steppe pastures of the gully-beam type on podzolized, leached and typical chernozems and gray forest soils.

It is characterized by high agricultural development: 64% of the area of the province is plowed. The share of protective elements of landscapes accounts for an insufficient (15–17%) part of the area. PKU are located mainly on the slopes and bottoms of logs and gullies, in floodplains of rivers, less often - in watershed areas.

The ecological state of the landscapes is tense and tense-crisis. It is necessary to increase the productivity and sustainability of agricultural land, optimize the use of natural resources in the territory with an increase in the share of protective, stabilizing elements of the agricultural landscape to 50–60%.
Yeletsky District is located in the western part of the Central Russian province of the forest-steppe zone. The area of the district is 1929.7 thousand hectares. Most of the district (90%) is located in the Lipetsk region, 10% – in the northern part of the Kursk region (Figure).

The district occupies the eastern spurs of the Central Russian upland with a slope to the Oka-Don Plain. The highest marks of the earth's surface are registered on the western border of the district in the range of 270–280 m above sea level. Towards the eastern border, the elevation drops to 235–245 m. On average, the absolute heights of the district do not exceed 250 m above sea level.

In landscape terms, the district is an erosional plain with a large-undulating, gently rolling relief with numerous gullies, ravines, with rare karst forms, and in some places with a westerly-potyazhin microrelief.

![Image](image_url)

Figure 1. Scheme agrolandscape-ecological zoning CCR

| Symbols | Description |
|---------|-------------|
| BF      | Broad-leaved forest zone |
| BF1     | Central Russian Province |
| FS      | Forest-steppe zone |
| FS1     | Levoberezhnodneprovskaya province |
| FS2     | Central Russian Province |
| S       | Steppe zone |
| S1      | South Russian Province |

The main soil-forming rocks in the district are loess-like loams and clays. The predominant type of soil is leached chernozems, medium-thick medium-humus clay and heavy-loam.
The district has a well-developed hydrographic network. Major rivers flow here: Voronezh (the eastern border of the district), Don, and Sosna. From small rivers stand out: Olym, Snova, Tim, Tuskar, Usozha. The river valleys are on average deepened to 150 m of absolute height. The Don Valley is cut even deeper (below 100 m). The significant difference in elevation between watersheds and deeply cut river valleys contributes to the development of ravines.

In the past, the watersheds of the district were occupied by meadow steppes and partly oak forests. Currently, more than 80% of the district's territory is occupied by agricultural land (arable land, pastures, hayfields).

The structure of land is dominated by arable land – 67% of the total area of the district, pastures occupy 11%, hayfields – 3%, forests – 7%, shrubs – 2%, under water and swamps – 1%, other land – 8%.

Oak and linden-oak forests with an admixture of other broad-leaved species are preserved in very small massifs, mainly in the Don basin. From secondary forests, most often in the district there are aspen pegs, confined to small depressions. Their distribution increases to the eastern border of the district in the interfluve of the Don and Voronezh.

The marshes are mainly concentrated in the floodplains of rivers: key peatlands with sedge-fluff vegetation, silty marshes with large grasses, horsetails and cattails. The keyholes in the bottoms of the beams are occupied by reed marshes. There are very few mainland marshes, mostly along the eastern border of the district. These are sedges of both sedimentary and ground feeding, the latter are strongly mossy.

The grass ecosystems of the meadow steppes preserved in places with mixed grass and grass stands and various pasture modifications on the site of these steppes are mainly used as natural grasslands (NG) and make up 79% of all NG of the Yelets District. They are placed mainly on beams and slopes. The most widespread are downed tipchak (valisian fescue) pastures on the slopes of different steepness (tipchak, narrow-leaved and meadow bluegrass, coastal rump, feather grass and hairy grass, low sedge, noble yarrow, steppe plantain, Austrian wormwood, thin-leaved peony). The yield of these pastures is 8–12 centners per hectare (c/ha) of dry eaten mass (DEM), medium-quality feed. Steep slopes are more often occupied by mixed grass-grass meadow-steppe vegetation with the dominance of six-leaved meadowsweet, tuber-bearing zopnik, meadow and steppe sage, silvery lapchatka, real bedstraw. From cereals grow here: steppe Timothy, fluffy oatmeal, combed keleria. Often, legumes are present in great abundance: mountain clover, Danish astragalus, horned lyadvenets, hop-shaped alfalfa, multi-colored elm. The yield of these grass stands both on hayfields and on pasture plots is 9–13 c/ha of DEM, the feed is of average quality.

The gentle slopes in the northern part of the district are characterized by vegetation of the moist steppe with abundant indicators of soil leaching: sweet spikelet, medium quagmire, sheep's fescue, meadow clover, common mantle, common blackhead, common nivyanik, lanceolate plantain, etc. The yield of hay here is 12–14 c/ha, and on pastures-8–10 c/ha of DEM. The feed quality is average.

The inter-girder leveled areas, the Baltic gentle slopes, and the dry bottoms of the girders are occupied by fine-grained groups of various grasses with dense blackness (viticultural and thin-leaved field grass, narrow-leaved and meadow bluegrass, creeping wheatgrass, sickle-shaped alfalfa, field scabbard, Siberian cut grass). The yield of hay and pasture is 10–15 c/ha of DEM, the feed is of good quality. In conditions of very intensive grazing, medium-to-heavy grazing areas with bluegrass-creep-cloverleaf grass stand up to knotweed failure are formed at these locations.

Often (especially in the eastern part of the district) there are small areas of pasture on sandy and sandy loam soils of above-floodplain terraces. The grass stands of such areas are characterized by sparseness and low productivity. Of the cereals here, the following predominate: Becker's fescue, sod bison, creeping wheatgrass, steppe timothy; legumes are represented by arable clover, various grasses-gray-green hiccup, noble yarrow, naked hernia, Pallas's thyme, Illyrian buttercup. The yield of these pastures is only 3 c/ha of DEM. The food is of poor and below average quality. The area of sandy pastures is small and accounts for only 2% of the total area of the NG.
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Lowland and westerly forage lands occupy less than 2% of the area of the NG and are characterized by a shallow contour. In the eastern lower part of the district, there are wet and damp depressions on saline soils with wheatgrass, wheatgrass-grass, beckmania-grass stands (creeping wheatgrass, common beckmania, meadow fescue, white vole, curl-leaved beskilnitsa, drooping sedge, Gmelin kermek, Besser carrot). The yield of mown plots is 12–15 c/ha, pasture plots-10–12 c/ha of DEM. The food is of medium and good quality.

The depressions on the watersheds and the bottoms of the gullies with provided ground moisture are occupied by grass stands with a predominance of sod pike, red fescue, white vole, lanceolate veynik, sod sedge. Raznotravye is represented by damp meadow species: goritsvet kukushkin, mountaineer cancer neck, buttercup creeping. The yield of hay on these lands is 15–18 c/ha, pasture feed – 10–15 c/ha of DEM. Medium-quality food. Pasture areas are usually boarded up.

Floodplain feeding grounds are of great importance in the district. They account for 15% of the NG area. Most of the floodplains of the district belong to the valleys of small rivers. The floodplain of the largest Don River is 0.75–1.5 km across.

Along the elevated drained floodplains, stalk meadows with coarse-stemmed weeds of various grasses are common. These are highly productive grass stands with the dominance of cereals of high forage value: the yield of hay reaches 25–30 c/ha, pasture – 12–15 c/ha of DEM.

On the dry bottoms of the beams, different herbs-grass groups predominate with red fescue, meadow bluegrass, Delyavinya keleria, meadow and hybrid clovers, early sedge, yellow bedstraw, common yarrow, large rattle, Austrian wormwood, etc. The yield of hay is 12–18 c/ha, pastures – 10–15 c/ha of DEM. Good quality food.

As part of the meadows of lowland floodplains, plant groups of provided moisture are common: moist large-grass-mixed grasses with cereals of high forage value, and damp and raw grass-sedge, pike-sedge, pike. These same grass stands occupy the wet and damp bottoms of the beams, but here they are mostly used for grazing, so they are often with bumps.

The Voronezh River floodplain is dominated by a moderately elevated central strip. Here, highly productive long-yielding fresh and moist meadows with a predominance of valuable forage cereals are common. The yield of hay in these meadows is 25–30 c/ha, and in favorable years it reaches 35 c/ha. The grazed areas are also high-yielding – 15–20 c/ha of DEM. The feed quality is good.

In the district as a whole, damp lands predominate from the long-term ones. This is dominated by white vole, beckmania, canary-beckmania-sedge, pike-grass stands, the yield of which is also quite high (hay – 20–25 c/ha, pastures – 15–20 c/ha). The quality of the feed is from medium to good.

Wetlands located both in floodplains and on the bottoms of gullies are used both for grazing and for haymaking, especially in dry years. The quality of these grass stands is low, since they are based on sedges and coarse-stemmed cereals. But when the grass stands of elevated locations burn out, the use of swampy meadows helps out.

Silty wetlands of variable moisture with mannik, common reed, cattails, horsetails and other marsh grasses give up to 20 c/ha of hay and more, sedge in the near-surface parts of floodplains and on key peatlands in the bottoms of gullies-twice less yield – 8–10 c / ha of hay.

4. Conclusions
According to the zoning data, it is established that the majority (75%) of the territory of the CCR belongs to the forest-steppe zone. The Central Russian province of the forest-steppe zone covers the main part of the territory of the CCR and occupies 11245.0 thousand hectares, or 67% of its area.
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Intensive human agricultural activity, excessive plowing of land and uncontrolled grazing of livestock have led to the development of erosion, reduced soil fertility, and degradation of pasture and hayfields vegetation.

Agrolandscape-ecological zoning and assessment of the state of grass ecosystems allow us to obtain the necessary information for the development of highly productive and environmentally friendly agriculture, ecosystem management, environmental management and environmental protection.

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