Nutritional value and productivity of perennial grasses used in animal feeding when creating cultural phytocenoses

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Abstract. The natural and technological properties of land and the conditions of the territory are determined by landforms, the contour of the fields and their fragmentation, and a number of other indicators related to the geographical conditions of the area. Their influence on agricultural activity and production is manifested directly through the features of the soil cover. Long-term studies carried out by employees of the Kursk Agricultural Academy have shown that the problem of restoring disturbed lands in the Kursk magnetic anomaly region can be successfully solved. One of the promising areas for the development of disturbed lands is the cultivation of perennial grasses directly on overburden. In the experiments, chalk, sands, soil mixtures, silts of the Jurassic, rocks of the Devonian system were used as a substrate for growing perennial herbs. In terms of chemical composition, these rocks are non-toxic and non-saline, at the same time they are poor in organic matter (0.1–0.4%) and mobile nutrients. The mechanical composition (except chalk) is light. Overburden rocks are characterized by increased bulk density (1.50–2.02 g/cm³) and solid phase density (2.70–2.86 g/m³). According to the four-membered classification of A M Burykin, the studied rocks are conditionally suitable and should be used for afforestation and tinning.

Having studied the dynamics of soil formation processes and changes in the humus content in rocks under natural and artificial (grasses 3 years of cultivation) phytocenoses compared with the breed in the quarry, an approximate rate of humus accumulation was calculated - 0.01% per year for young (3-5 years) dumps; 0.02% per year on old (20–23 years) dumps under slope conditions and 0.03–0.08% per year on upland areas under natural phytocenoses. Under perennial grasses of the 3rd year of cultivation, it is respectively 0.2–0.25% per year for young and 0.1–0.2% per year for old dumps. Consequently, the rate of humus accumulation under perennial grasses is 1.5–2.0 times higher than under natural vegetation, and the cultivation of ecotope of young dumps by herbs is more intensive than old dumps.

According to the results of previous studies, a number of scientists give their preference to perennial leguminous herbs with a high nitrogen-fixing ability, a powerful and deeply penetrating root system that can cover a large volume of rock and extract scattered nutrients and water from it. In addition, legumes are able to translate in the dissolved state of inaccessible phosphorus compounds. Thus, the studied results show the fundamental possibility and prospects of carrying out the biological stage of reclamation of dump soils using perennial legumes without applying a fertile soil layer [1,2,3].
Overburden is a favorable substrate for perennial leguminous grasses (table 1). However, the significant influence of the agricultural background was significant in the cultivation of vegetation. For biological development, the most difficult to use are the soils, sand-clay, deposits of the Devonian system and sands. On these backgrounds, grass productivity was the smallest. The crop of herbs on other breeds was at the level of adjacent zonal soils.

Studying the root mass of perennial grasses for a three-year period of use (layer 0–50 cm) made it possible to evaluate the features of its distribution and accumulation depending on the properties of the rocks. The bulk of the roots is concentrated in a layer of 0–30 cm and accounts for more than 80% of their total number. On all backgrounds, the underground mass exceeded the aboveground, and this is justified. Such an intensive development of the root system is associated with a lack of nutrients and water in the plant substrate, which causes plants to develop a significant root system [4,5,6].

Table 1. Productivity of perennial grasses cultivated on the rocks of Stoilensky GOK (average data for 3 years).

| Herbs                  | Overhead weight, 100 kg/ha | Plant residues, rhizomes, 100 kg/ha | Total biological yield | Plant residues, roots, in the total mass, % | Productivity ratio |
|------------------------|-----------------------------|-------------------------------------|------------------------|---------------------------------------------|--------------------|
|                        | Chalk                       |                                     |                        |                                             |                    |
| Sainfoin sand          | 16.2                        | 20.9                                | 37.1                   | 56.3                                        | 0.78               |
| Alfalfa synehybrid     | 15.1                        | 18.6                                | 33.7                   | 35.2                                        | 0.81               |
| Sainfoin sand + fescue meadow | 13.2                 | 16.1                                | 29.3                   | 54.9                                        | 0.82               |
|                        | Sand                        |                                     |                        |                                             |                    |
| Sainfoin sand          | 13.9                        | 25.7                                | 39.6                   | 64.8                                        | 0.54               |
| Alfalfa synehybrid     | 12.9                        | 24.9                                | 37.8                   | 65.8                                        | 0.51               |
| Sainfoin sand + fescue meadow | 8.7                    | 15.8                                | 24.5                   | 64.5                                        | 0.55               |
|                        | Soil mixture                 |                                     |                        |                                             |                    |
| Sainfoin sand          | 18.8                        | 29.8                                | 48.6                   | 61.3                                        | 0.63               |
| Alfalfa synehybrid     | 18.2                        | 28.9                                | 47.1                   | 61.3                                        | 0.63               |
| Sainfoin sand + fescue meadow | 15.8                | 22.7                                | 38.5                   | 58.9                                        | 0.69               |
|                        | Aleurites of Jurassic        |                                     |                        |                                             |                    |
| Sainfoin sand          | 18.9                        | 30.7                                | 49.6                   | 61.8                                        | 0.61               |
| Alfalfa synehybrid     | 26.4                        | 39.1                                | 65.6                   | 59.6                                        | 0.67               |
| Sainfoin sand + fescue meadow | 15.6               | 21.9                                | 37.5                   | 58.4                                        | 0.71               |
| Sainfoin sand          | 2.6                         | 4.9                                 | 7.5                    | 65.3                                        | 0.53               |
| Alfalfa synehybrid     | 3.8                         | 6.6                                 | 10.4                   | 63.4                                        | 0.57               |

On average, for the formation of soils with a humus content of 1% (zonal chernozem), it is necessary from 500 to 1000 years in the conditions of slopes and 125–300 years in upland areas under natural vegetation. Herb thinning will reduce this period to 40–100 years. Such high rates of humus accumulation in technogenic landscapes are explained by their environment (developed zonal soils and vegetation), as well as the presence of individual fertility in the rocks themselves. It is restored mainly by biological factors, i.e. vegetation and organisms that inhabit the soil. The cultivation of perennial grasses on dumps also contributes to the accumulation of humic acids [7,8,9].

Perennial grasses are a significant reserve for increasing feed production and one of the ways to protect soil from erosion on the beam slopes of the Central Black Earth Zone, which itself expresses the creation of new hayfields. With a radical improvement, the yield of natural fodder land increases by 3-5 times, the flow of melt water on the slopes decreases, and from the second year of life, seeded grasses protect the soil from erosion.
The agrotechnical significance of sainfoin is great in agriculture. In agronomy, it is represented as a precursor for many cultures, and it is specially grown on low-fertile soils [10,11,12,13]. Sainfoin (Onobrychis arenaria D. C.), better than other legumes enriches the soil with nitrogen, due to the greater development of nodules on its roots. In addition, sainfoin nodules are resistant to high temperatures and soil drought. The valuable qualities of sainfoin allow it to be used on green fodder, hay, hay, silage and vitamin grass meal.

Alfalfa (Medicago x varia Martyn) is the main perennial bean grass in the Central Chernozem Region. In nutrition, it occupies a significant place among other feed crops. Green mass, hay and other feed from it are distinguished by high feed perfection, rich in protein, vitamins and mineral salts. Digestible protein is superior to similar forage herbs. According to the All-Russian Research Institute of Feed, in the flowering phase, 100 kg is fresh. The cultivation of alfalfa in soil-protective crop rotations mixed with rhizome cereals on the slopes is analyzed as an indispensable element in the complex of measures to combat water and wind erosion. The mixtures are better wintered and give stable yields for a longer time, almost do not thin out, are weaker inhibited by weeds and are almost not damaged by pests.

Meadow fescue (Festuca pratensis Huds.) - perennial perennial bush perennial grass. It is used as a sowing in field crop rotations and is included in complex grass mixtures. It provides highly nutritious food in the form of green grass, hay. Feed value is higher than meadow timothy. Hay contains up to 14% protein, 100 kg of hay contains 60 feed units and 4.2 kg of digestible protein. Fescue is a solid structural educator of landscapes and soils, forms a large number of roots, starting from the tillering phase. The maximum root system is formed in the second year of life. According to the accumulation of root mass, it occupies a leading place among other cereal grasses. The root mass is rapidly corroded, recreating the structure of the soil and increasing its fertility.

The bonfireless campfire (Bromopsis inermis Holub.) Is an excellent hayfields and, as one of the components of grass mixtures, a pasture plant. Of significant value for sustainable pastures and forage meadows. Introducing it into grass mixtures with legumes multiplies the yield of hay and pasture feed, and establishes circumstances for the favorable growth of grass stands. The rump is boneless, it is characterized by significant winter hardiness, good dumping, it is responsive to irrigation and fertilizers, it gives significant yields of green mass and hay. In our zone, the boneless rump is the most essential component in grass mixtures when the floodplains of rivers and sloping lands are tinned.

The effectiveness of the radical improvement of beam slopes for hayfields to a large extent also depends on the proper use of mineral fertilizers. Fertilizers contribute to a sharp increase in the productivity of perennial grasses, maintaining for a long-time high yield of seeded grasses and the formation of a dense grass stand [14,15,16,17].

Studies on the effectiveness of the use of nitrogen fertilizer were carried out on the slopes of the Stoilensky GOK on a soil mixture in the version with a set of herbs: sainfoin + meadow fescue with the addition of beanless rind.

The results of the studies showed that the application of fertilizers contributes to an earlier growth of the grass stand from spring and an increase in its density. On variants with fertilizer, grass growth with spring resumption of growth began 3-4 days earlier than on other variants (without fertilizers). The densest grass stand was formed upon application of N90 and N120 according to the phosphorus-potassium background where the number of shoots per 1 m² was 2048–2108 pcs., And on the variants without fertilizers - 1304-1550 pcs. An increase in the density of the grass stand occurred to a large extent due to the intensive tillering of the boneless rump. The number of shoots of beechless rump in the herbage on the fertilized version increased 1.4 times, meadow fescue 1.2 times. Phosphorus-potassium fertilizers did not have a significant effect on the formation of shoots of beefless rump and meadow fescue.

The increase in nitrogen from 60 to 120 kg/ha increased the height of the boneless rump 1.2 - 1.4 times, meadow fescue 1.2 times.

Along with an increase in the density of the grass stand and plant height, nitrogen fertilizer contributed to a significant increase in the productivity of the grass stand.
On average, over 3 years the yield of cereal grass on options without fertilizing amounted to 42.1–43.0 100kg/ha of hay.

With the introduction of nitrogen fertilizer (N), the productivity of the grass stand increased by 7.7 100kg/ha, and nitrogen fertilizer in the norm of N$_{60}$, N$_{90}$, N$_{120}$ by phosphorus-potassium background, respectively - by 17.6, 21.6, 26.7 100kg/ha. Phosphate-potassium fertilizer did not have a significant effect on the productivity of cereal grass, which is due, first of all, to the biological characteristics of cereal grasses, which are more responsive to nitrogen fertilizer, and especially on eroded lands, overburden dumps, and sloping lands. Nitrogen fertilizer had an effect on the content of crude protein in the herbage. The introduction of nitrogen at a rate of 60 kg / ha increased the protein content in the herbage by 1.7% compared with others that did not receive a share of feeding. With an increase in the rate of nitrogen fertilizer, the protein content in herbs increases. When N$_{90}$ – N$_{120}$ was added, the protein content in the herbage was 2.1–2.7% higher than in other neighboring variants. Providing high productivity of grass stand, and increasing the protein content in herbs, nitrogen fertilizer helps to increase the collection of protein per unit area. When using nitrogen fertilizer with a norm of 60 kg/ha, the collection of gross protein was 0.9 100kg/ha, more than when applying a dose of 90–120 kg/ha on average by 1.3–1.8 100kg/ha.

Another positive effect, which is confirmed by science and best practice. It has been established that an effective way to increase the productivity of artificially formed, sowed and natural forage lands, both on slopes and dumps, is a radical improvement, additional sowing, in which their productivity increases by 3-5 or more times [18,19,20].

In the process of the scientific experiment, slopes of the northern and southern exposures with steepness up to 12–16 ° were used. In this case, we studied the effect of seeding rates (10, 20, and 30 million germinating seeds per 1 ha) and the ratios of cereals and legumes (cereals 100%, cereals 70% + legumes 30%, cereals 40% + legumes 60%) on density and productivity.

The research results showed that with an increase in the seeding rate, the density of the grass stand increases, and at the same time, its soil-protective effect increases. In the first year of use, the number of shoots per 1 m$^2$ at a sowing rate of 20 million germinating seeds per 1 ha was 1.3–1.5 times more than at a sowing rate of 1 million germinating seeds, and at a sowing rate of 30 million seeds, respectively 1.4–1.7 times. In the third year of using herbs, cereal-bean grass stands, and on the southern slope and legume-cereal practically did not differ in density at rates of 20 and 30 million seeds per 1 ha.

The number of shoots for the third year of using herbs at a sowing rate of 20 million pcs / ha of seeds amounted to 2048–3264 pcs/m$^2$ on the northern slope, 2624 pcs/m$^2$ on the southern slope in 2016. But an increase in the seeding rate to 30 million pcs/ha of seeds does not provide a significant increase in the number of shoots.

The seeding rate and the ratio of legumes and cereal components have a significant effect on the yield.

The highest hay yield for 3 years was obtained with a sowing rate of 20 million germinating seeds per 1 ha, on the slope of the northern exposure cereal-bean grass mixture (cereals 70% + legumes 30%) 75.5 kg/ha, and on the southern - leguminous-cereal the mixture (cereals 40% + legumes 60%) 64.5 kg/ha, which is respectively 22% and 42% higher than when sowing cereal grass mixtures.

With an increase in the sowing rate to 20 million germinating seeds per 1 ha, the yield of grass mixtures on the girder areas and on overburden dumps, on the southern slopes increased by 10-14% compared with grass mixtures with a sowing rate of 10 million seeds per 1 ha.

It is important to establish optimal seeding rates and the ratio of cereals and legumes in the mixture on the dumps of hayfields, on these created lands, on technogenic soils. This is of great importance not only to increase the productivity of the land, but also to create a dense grass stand capable of forming young technogenic soils, herbaceous phytocenoses that can protect the soil both from erosion and from disturbing the natural landscape of the earth's surface.

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