Technologies for the rational use and improvement of hayfields and pastures in arid territories of Russia

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Abstract. Materials are presented on the enrichment of natural hayfields and pastures in the south of the European Territory of Russia (ETR) with valuable forage grasses by methods improvement. The work is based on modern methods of landscape-bio-ecological research using scientific and practical methods for restoring and prolonging the productive longevity of pastures. Effective measures to improve forage land provide an increase in productivity of 1.5-2.0 times compared with natural pastures. Agrotechnical methods are given, including soil preparation, norms and timing of sowing. Attention is paid to the selection of sown species, the composition of mixtures and the ratio of the life forms of herbs.

1. Introduction
Pasture degradation is a multi-level complex process that requires a multifaceted approach for solving, especially in sandy areas with a high probability of deflation. This is relevant for more than 75 million hectares of the territory of the south and southeast of the European part of Russia (ETR), which is the forage base of traditional pastoral livestock. The feed base is independently renewed annually, subject to grazing standards [1-3].

However, these norms are often not respected, which leads to degradation of pastures. Complete plant communities turn into depleted, and soils lose their humus and are depleted. The loss of humus is 25-30%. In addition, about 60% of the pasture territory is subject to wind erosion. All this leads to a depletion of biodiversity and a sharp decrease in productivity. By enriching the grass cover with species adapted to arid conditions, taking into account the norms of grazing animals on pastures, this problem can be solved. The enrichment of phytocenoses with valuable forage grasses is one of the main principles of pasture improvement. The most important condition for improving hayfields and pastures in the arid territory is the development of agrotechnical methods for growing highly productive forage grasses. Pasture condition monitoring is necessary to be able to assess the changes that will occur [4]. In this regard, it is necessary to create technologies for the rational use of highly productive natural hayfields and pastures through their superficial and radical improvement [5-8].

2. Materials and methods
Pastures of the south and southeast of the European part of Russia are the objects of this study. The scientific work is based on modern methods of landscape-bioecological research using scientific and practical methods for restoring and prolonging the productive longevity of pastures [9, 10]. An assortment of forage grasses is presented, which are used to improve pasture lands in the south of the
European part of Russia. The norms and methods of sowing forage grasses to improve pasture lands were determined. Reclamation techniques for increasing the productivity of natural estuaries are presented. They are based on agrotechnical methods to increase the yield of grass stands without plowing and with the rational use of technology by sowing high-yielding zoned varieties and types of herbs.

3. Results and Discussion

Studies of the current state of ETR pastures allow us to conclude that it is possible to increase the productivity of fodder land 1.5-2.0 times compared to that of natural pastures [11]. Effective pasture improvement methods are based on the ecology and biology of fodder plants in agrotechnical experiments [12].

The main forage grasses on hayfields and pastures ETR are: Elytrigia elongata (Host) Nevski, Elytrigia repens (L.) Nevski, Agropyron pectinatum (Bieb.) Beauv., Agropyron fragile (Roth) P. Candargy, Agropyron desertorum (Fisch. ex Link) Schult., Agropyron tanaicum Nevski, Agropyron lavrenciunanum Prokudin, Medicago lupulina L., Dactylis glomerata L., Bromopsis inermis (Leyss.) Holub, Astragalus virgatus Pall., Astragalus vereschaginii Kryl., Astragalus hyrcanus Pall., Astragalus longiflorus Pall., Astragalus ammodendron Bunge, Astragalus brachylochus Fisch., Astragalus cicer L., Astragalus arenarius L., Astragalus onobrychis L., Poterium sanguisorba L., Poterium polygamum Waldst. & Kit., Glycyrrhiza glabra L., Glycyrrhiza uralensis Fisch., Poa bulbosa L., Poa stepposa (Kryl.) Roshev., Kochia densiflora (Moq.) Aell., Kochia prostrata (L.) Schrad., Kochia laniflora (S.G. Gmel.) Borb., Artemisia leichiana Web., Artemisia scoparia Waldst., Artemisia arenaria DC., Artemisia tschernieviana Bess., Camphorosma lessingii Litv. and etc. All of these plant species give an increase in the yield of fodder mass (0.9-36.0 t / ha) of hay and seeds (0.2-0.5 t / ha) depending on the cultivation zone and method of use [13].

Perennial cereal-bean plant species in the dry-steppe and semi-desert zones of the ETR form 65 % of the crop until mid-summer. The period of productive longevity of such plant communities is 2-5 years. Shrubs form a crop during the summer-autumn period with a productive longevity of 12-16 years. Phytocenoses are recommended to be formed from three to five species of different life forms (legumes, cereals, shrubs).

When compiling a mixture of herbs, it is necessary to take into account botanical features that determine the competitiveness of the species. The growth and development of fodder plants during the growing season depends on the duration of sunlight, air humidity and moisture available to plants in the root layers of the soil. When sowing fodder land, preference is given to plant species that are well adapted to harsh agro-climatic conditions, yield high yields during pasture ripeness and are rich in nutrients.

The selection of the sown species and the composition of the grass mixture mainly depends on environmental conditions, methods for improving pasture and seed material. When biomeliorants are introduced into the culture, species with a short, medium and longer development cycle should be included in the sown mixture. In the presence of seeds of plants of various life forms, the mixture is based on the norms of sowing seeds.

Created phytocenoses from shrubs and herbs accumulate the highest supply of fodder mass and exceed the yield of natural pastures. When improving natural pastures, monocomponent crops from shrubs and grasses are used (Bassia laniflora (S.G. Gmel.) A.J. Scott, Camphorosma lessingii Litv., Agropyron pectinatum (Bieb.) Beauv., Elytrigia elongata (Host) Nevski, Astragalus arenarius L., Astragalus dasyanthus Pall.) and other types of feed plants.

Technology for improving natural fodder land can only be successfully implemented with high-quality seeds. Seed areas are laid by seeds collected in existing arrays of artificial pastures. Seeds of plant species that are of interest to improve different types of pastures and suitable for different periods of use are collected.

The complex of agrotechnical methods for obtaining highly productive long-term resistant grasses includes: site selection, soil cultivation, sowing placement, sowing dates, seed sowing rates, sowing
methods and techniques, seed placement depth.

Natural massifs with a predominance of grass species with low phytocenotic activity or disturbed areas with poor vegetation are selected depending on the term of use of pastures (spring-summer, summer-autumn, year-round).

Plowing is carried out to a depth of about 20 cm. Then, on a lumpy-clumpy soil, disk peeling is carried out to a depth of 7-8 cm. Harrowing is carried out to destroy weed seedlings and to save moisture in the spring. Then pre-sowing cultivation with harrowing and rolling before and after sowing is carried out.

The best dates for sowing seeds of fodder plants in the dry-steppe and semi-desert zones of the ETR for shrubs are late October-early November, perennial grasses-mid-October. The seeds are laid on the leveled surface of the soil to the optimum depth for shrubs of 0.5-1.0 cm, for grasses – up to 3 cm. Rolling is carried out simultaneously with sowing. An important agrotechnical technique for sowing is to establish the optimal seed rate. Hard-coated seeds need to be stratified. Due to the poor flowability of many seeds of feed plants, the seed should be mixed with sand in a ratio of 1: 3. The established norm of seeds for shrubs and herbs is presented in table 1 [7, 10].

Table 1. Norms and terms of sowing fodder plants

| Plant species | Seeding rate, kg / ha | Sowing dates          |
|---------------|-----------------------|-----------------------|
| *Agropyron sibiricum* (Willd.) Beauv., *A. lavrenkoanum* Prokudin, *A. pectinatum* (M. Bieb.) P. Beauv. | 10-12 | 6-8 | September - 1st decade of October |
| *Agrostis gigantea* Roth | 8 | 6 | Spring period |
| *Alopecurus pratensis* L. | 18-19 | 14-15 | Spring period |
| *Astragalus virgatus* Pall., *A. onobrychis* L., *A. veresczaginii* Kryl., *A. hyrcanus* Pall., *A. longiflorus* Pall., *A. cicer* L., *A. ammodendron* Bunge, *A. brachylobus* Fisch., *A. arenarius* L. | 19-24 | 12-16 | 1st decade of October |
| *Bromopsis inermis* (Leyss.) Holub | 22-25 | 18-19 | October |
| *Camphorosma lessingii* Litv. | 8-9 | 6-7 | 1st decade of November |
| *Dactylis glomerata* L. | 16 | 8-10 | October |
| *Elymus novae-angliae* (Scribn.) Tzvelev | 16-18 | 9-12 | October |
| *Festuca pratensis* Huds. | 6 | 4-5 | October |
| *Festuca arundinacea* Schreb. | 18-20 | 14-15 | Spring period |
| *Medicago lupulina* L. | 10 | 6-7 | Spring period |
| *Medicago romanica* Prod. | 13 | 9-10 | Spring period |
| *Poa bulbosa* L. | 17-18 | 12 | October |
| *Phleum pratense* L. | 14 | 10 | Spring period |
| *Salsola orientalis* S.G. Gmel. | 10-11 | 8-9 | 1st decade of November |
| *Sanguisorba officinalis* L. | 19-25 | 11-13 | 1st decade of October |

To provide seed material, it is advisable to create seed plots that differ in more favorable soil and climatic conditions, in compliance with the whole complex of agrotechnical requirements. Sparse crops with row spacing of 60-70 cm are used for selection and seed-growing of semi-shrubs. The main method is mechanized sowing of grain-grass seeders. Used shrubs are *Camphorosma lessingii* Litv., *Krascheninnikovia ceratoides* (L.) Gueldenst., *Bassia laniflora* (S.G. Gmel.) A.J. Scott, *Astragalus virgatus* Pall., *Astragalus veresczaginii* Kryl., *Astragalus hyrcanus* Pall., *Astragalus longiflorus* Pall., *Astragalus ammodendron* Bunge, *Astragalus brachylobus* Fisch., *Astragalus cicer* L., *Astragalus*
arenarius L., Astragalus onobrychis L.

The meadow vegetation of estuary meadows is mainly represented by perennial herbs, the root system of which retains its vital activity for many years. The highest yield of hay with the best nutritional properties develops on hayfields with the optimal ratio of moisture supply, soil conditions and species composition of vegetation. In violation of these conditions, there is a need to improve meadows.

Land reclamation techniques for increasing the productivity of natural estuaries provide hay yields of 5-6 t/he. At the same time, rational use of water resources, improvement of the ecological and reclamation state and soil fertility, and the production of environmentally friendly feed with good quality appear. Agricultural practices are carried out without plowing the meadow and with the rational use of technology. Grass cover is created on the basis of high-yielding zoned varieties and types of herbs (table 2) [14].

| Table 2. Technological scheme of superficial improvement of estuaries |
|---------------------------------------------------------------|
| Technological operations            | Agrotechnical requirements and terms of work                        |
| Improvement of natural grass cover | Raking: If there is garbage in the spring after meltwater           |
|                                    | Garbage collection and disposal: Garbage collection and disposal after raking with nozzle-flare devices |
| Leveling the surface of the meadow and replanting grass mixtures | Disking: To a depth of 5-7 cm in the presence of a relief from plowing the meadow after the first mowing |
|                                    | Soil leveling: Leveling the soil (up to 5-10 cm) after diskng      |
|                                    | Additional grass sowing: With insignificant participation of cereals in the grass cover, they are selected taking into account the flood of the site; 50% of the recommended rate is sown per year without flood – in April, with flood – in September on fresh, discarded turf. |
| 1-2 rolling, depending on soil moisture | Rolling: With biaxial use: the first mowing - at the beginning of flowering cereals, the second – in mid-September; cutting height 5-7 cm; with single use, during the flowering phase of the predominant cereal species (June-July). |

In March-April, before the start of grass growth, they burn out if there is a large amount of debris and shrubs, pre-localize areas by plowing. An additional sowing of grass mixtures is carried out on thinned grass coverings with a low cereal content (Table 3).

| Table 3. Herb mixtures and sowing rates of floodplain meadows (kg / he) |
|---------------------------------------------------------------|
| Meadow floodplain conditions                    | Medicago lupulina L. | Bromopsis inermis (Leyss.) Holub | Festuca pratensis Huds. | Phleum pretense L. | Alopecurus L. | Total |
| up to 10-15 days                                 | 6-10                | 10-12                            | 10-12                   | -                 | -               | 30-32  |
| up to 15-20 days                                 | -                   | 10-12                            | 6-8                     | 5-6               | -               | 23-24  |
| up to 25-30 days with close groundwater level    | -                   | -                                | -                       | 10-12              | 10-12           | 27-28  |
| over 30 days with close groundwater level        | -                   | 28                               | -                       | -                 | -               | 28     |

The first mowing is carried out in the phase of the beginning of flowering of the predominant species, the second - in mid-September; with single use – in the flowering phase.
The main technologies for the radical improvement of estuaries are: measures to prevent water erosion of the plowed floodplain, including accelerated tinning and selection of special grass mixtures, based on grass varieties zoned for floodplain conditions (Table 4) [13].

Table 4. Technological scheme of radical improvement of estuaries

| Technological operations   | Agrotechnical requirements and terms of work                                                                 |
|----------------------------|---------------------------------------------------------------------------------------------------------------|
| Primary soil cultivation   | Primary tillage:<br>With heavy and cohesive soil (up to 22 cm), milling in 1-2 tracks or disking in 3-4 tracks, then plowing to a depth of 18-20 cm with subsequent disking.  |
| Presowing tillage          | Disking, harrowing, leveling: 2-3 passes of the unit to a depth of 7-15 cm (depending on the severity of the soil) immediately after plowing.  |
| Presowing soil rolling     | Presowing soil rolling: 1-2 passes (depending on soil moisture and the degree of cutting turf) immediately after disking (before sowing).  |
| Grass mixture selection    | Meadow creation: Grass mixtures are selected taking into account the duration of spring flooding. (Table 3) |
| Sowing                    | In the spring, under the cover of annual grass, in the summer (1st-2nd decades of July), it is coverless, while the seeding rate of the cover crop is reduced by 25-50%.  |
| Post-sowing rolling       | Post-sowing rolling: 1-2 passes (depending on soil moisture and the degree of cutting turf) immediately after sowing.  |
| Harvesting a cover crop of grass on green feed. Mowing grass in the year of sowing.  | Grass care in the first year of sowing: The cover culture (in the phase of the beginning of the formation of ears) is mowed at a height of 7-8 cm and harvested for 1-2 days. When a large number of weeds appear, they mow at a height of 6-7 cm a month before the onset of frost or after the average daily temperature rises above 0 ° C.  |
| Mowing grass twice        | Processing grass for hay: The first mowing is carried out at the beginning of flowering cereals, the second - until mid-September  |
| Tedding and raking grass   | The time interval between tedding and raking should not be more than 4-5 hours.  |
| Stacking hay, loading, transportation | These technological operations should be performed in the morning and evening hours in order to prevent loss of legume leaves; Accumulation is carried out at a moisture content of hay of 30-35%, and at 20-22%.  |

The correct selection of fodder plants for single-species and multi-species phytocenoses is of primary importance. It is advisable to create pastures for different periods of use based on a combination of different life forms of fodder plants.

When restoring pasture ecosystems, it is necessary to take into account that a more rational use of resources will be in communities that are modeled on the type of natural zonal biocenotic structures. This is achieved through a combination of zonal-typical dominant forage grass species, taking into account the adaptive strategy. The design of pasture systems, especially in areas subject to deflation, should consist of adapted shrubs, perennial and annual grasses in certain proportions depending on the purpose and functionality of the pasture.
4. Conclusion
Natural fodder land should be cost-effective and environmentally friendly. Their creation leads to the preservation of productive longevity and increased soil fertility. When creating fodder lands, it is important to consider the selection of species and ecotypes of vegetation, as well as their biological and phytocenotic compatibility in regional conditions. If you follow all of the above factors and adhere to the agrotechnical methods of growing feed crops, you can expect tangible indicators of the yield of fodder mass (0.9-36.0 t / ha) of hay and seeds (0.2-0.5 t / ha), depending on cultivation zones and method of use.

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