Deer Pasture Productivity and Crop Yield in Anabarsky Ulus of the Republic of Sakha (Yakutia)

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Abstract. This article presents the results of the research into the crop yield and productivity of deer pastures in the Republic of Sakha (Yakutia). Currently, the policies aim to preserve and increase the headcount of local breeds of domesticated reindeer. Due to this, we researched the food resources of deer pastures in Anabarsky Ulus. Laboratory research and livestock analysis of the food resources of deer pastures were carried out at the clinical diagnostic research laboratory of the Arctic State Agrotechnological University. The analysis of soil was carried out at the laboratory of the Agricultural Service State Budget Company under the auspices of the Ministry of Agriculture of the Republic of Sakha (Yakutia). The authors prove that the crop yield of natural deer pastures reaches up to 41.3 dt/ha at the total power of 38.4 GJ/ha, 2891 fodder units, and 198 kg of raw protein. Day-long deer pasturing plays an important role in preserving pastures. This system stipulates that the herdsmen actively control the herd and change the pastures daily depending on the deer's need in grazing and having rest and taking into account the weather conditions, as well as the availability and quality of fodder.

1. Introduction
Russian Federation is the largest country and economy in the world that practices deer farming. For smaller peoples of the Russian North, deer farming is of special social and political importance, as it is the key component of their identity and traditional trade. Deer can efficiently use millions of hectares of pastures in the tundra and wooded tundra zones that cannot be used by other animal species. That is why deer farming is so crucial in the Republic of Sakha (Yakutia).

2. Relevance and novelty
Natural forage lands are used year-round to transform plant resources of the Far North into useful products (meat, leather and fur, raw materials, etc.) whose quality depends on the quality of the food resources and the methods of their exploitation. Currently, the policies aim to preserve and increase the headcount of local breeds of domesticated reindeer. The available fodder is insufficient due to the degradation of deer pastures [1]. The following research works deal with the studying of deer pastures in the arctic part of the Republic of Sakha (Yakutia).

3. Statement of problem
The goal of this research work is to perform a comprehensive assessment of food resources and rationalize the use of deer pastures in the Republic of Sakha (Yakutia).
4. Theory
Circumpolar species make up about 90% of the arctic tundra flora. This means that tundra flora is unique, and local species eliminate other plants that are not capable of surviving in harsh conditions. In high arctic ecosystems, the number of higher plant species is under 100, in the Arctic, it is between 100 and 200, and in subarctic - 150-300 species. A total of about 800 higher plant species grow in the tundra zone, and about 500 of them are circumpolar. The first geobotanical studies of the vegetation in the plain and mountain tundras in the lower reaches of the river Anabar were performed by Viktor Borisovich Sochava. He noted the diversity of local vegetation and classified plant species. He identified and described 5 groups of associations: arctic low bush, lichen, moss, hydrophytic grass, and mesophytic grass [2].

The classification of the tundra is based on the further differentiation of the zoning principle, as well as other types of tundra vegetations based on the ecological and topological principle. The key vegetation types of Yakutian tundra include: The tundra vegetation can be divided into two subtypes: arctic and subarctic tundras.

*The arctic tundras* have very few vascular plants but a lot of spore plants: bryophytes and lichens. In terms of species composition, the proportion of vascular plants and mosses is close to 1:1. Arctic and arctic-alpine species are dominant among the higher plants. Homogeneous phytocoenoses are almost non-existent. The phytomass reserves in the arctic tundra are several times lower compared to the subarctic. The annual increase of the phytomass is decreasing against its reserves. Phytocoenoses become more vulnerable to zoogenic and anthropogenic impacts. The recovery of the damages incurred is slowed down. The grazing capacity of pastures in the arctic tundra is decreasing rapidly. The arctic tundra subtype determines the location of the arctic tundra subzone.

*Subarctic tundras.* Apart from the orders typical of the arctic tundra, the subarctic tundra subtype includes the order of bush communities. The same bush species are attributed to a specific component of mosaic phytocoenoses. Subarctic bushes are low and dispersed. Generally, their height does not exceed 25-30 cm, and they cover up to 30-50% of the total land area of the phytocoenosis. In bushy vegetation areas, they form a solid layer of over 50 cm high. Sparse and low bush tundra is typical of subarctic tundras. Sometimes, they can be found in the arctic tundra subzone, which they only reach if there are favorable growing conditions. Thus, they sometimes reach the coast of the Arctic Ocean near the Lena and Kolyma deltas.

*Arctic herb nival meadows* are formed around melting snowfields under abundant flowing moisturization. Their development begins when the land surface is cleared of snow, as a rule, 15-30 days later than the surrounding tundra. The vegetation period is very short. Such territories are dominated by the arctic species with short vegetation periods, mostly miniature plants from the buttercup, pink, gentian, poppy, rose, legume, sunflower, and other families, typical of higher latitudes. These plants moved to the south or down the slopes from the high-latitude tundra and mixed with local short-vegetation species due to the impact of edaphic factors. This subtype is extremely important for herbivore animals, especially reindeer, as a source of fresh greenstuff when in the majority of other phytocoenoses the green matter is wilted due to autumn. Large sections of such nival meadows determine the migration routes of wild deer.

*The subnival tundra meadows* develop at snowdrifts on mountain and hill slopes with well-drained sandy soils. Unlike nival meadows, they develop under insufficient moisturizing, especially in the second half of the vegetation period. Their vegetation is more xerophytic. They feature more cereals, sedges, small mesophytic sedges, green mosses, and lichens. Through a number of transitional associations, this subtype is connected to tundra aggregations. Instead of mesophytic grasses typical of meadows, these areas are dominated by bryophytes and low bushes. The tundrification of this subtype of meadows is due to the reduction of snowdrifts and their faster melting due to the borealization of the tundra.

*Sedge and cereal lakeside meadows* take up equal terraces around lakes. They are represented by hydrophytic grasses from the sedge, cotton-grass, alkali-grass, Dupontia, and pendant grass genera.
The stage of sedge and cereal lakeside meadow is short. As these communities age, they become covered in mosses and willows.

Cereal and sedge coastal halophytic meadows develop on marshy soils along the sea coast and in estuaries. They occupy a thin strip of the youngest terraces and are sometimes flooded by seawater.

Mesophytic flood plain meadows take up small strips in narrow flood plains of tundra rivers. They are often located on the upper parts of flat banks and represented by pioneering aggregations on young alluvia, or they can be attributed to lowlands between ridges in the mid-alluvial plains, interspersed with bushes on the ridges. Such meadows are often formed by the equisetic and cereal grass stands. Flood plain meadows are a very dynamic subtype. Like lakeside meadows, they can be used as hayfields [3].

5. Research findings

To perform the research, we selected the following basic farm: Municipal Unitary Enterprise n.a. I. Spiridonov, Located in Anabarsky district on the coast of the Laptev Sea, 2855 km from Yakutsk. This farm breeds Evenki reindeer in the subarctic tundra of the North-East of the Russian Federation. The last delivery of pedigree animals from the Verkhoyansk district took place in 1969.

Laboratory research was carried out at the clinical diagnostic research laboratories of Yakutian State Agricultural Academy and Agricultural Service State Budget Company of the Republic of Sakha (Yakutia).

The soil in the land plot in question is tundra gley and tundra humic gley with a neutral pH index between 5.1 and 6.7, humic content between 5.1 and 6.3 %, a nitrate-nitrogen content of 2.7 mg/kg of soil, a content of active forms of phosphorus of between 26 and 34 mg/kg, and a content of exchangeable potassium between 46 and 69 mg/kg of soil. The soil is slightly saline, chloridic.

According to the number of species and dominant families, the deer pastures in question are Flora II type: arctic, 100-200 species. They are dominated by cereal, sunflower, and cabbage families. Boreal species make up 30-40% of the flora. Judging from the geobotanical description of the food resources, the deer pastures of the arctic part of Yakutia are dominated by sedge and cottongrass verdant tundras. We identified the following communities: cotton-grass-and-herb, cereal-and-herb, cereal-and-willow, bryophytic-and-herb, cereal-Scheuchzer cottongrass, and bryophytic-sedge. The dominant species include Carex Aquatilis Var. Minor, and common cottongrass. Tundra vegetation depends on the climate conditions during the vegetation periods. Thus, it is vulnerable to zoogenic and anthropogenic impacts, which naturally results in the succession of plants and further impacts the productivity of deer pastures, and the reduction of the species composition in tundra meadows (Figure 1).

![Figure 1. Space photograph illustrating the reduced quality of fodder and pasture degradation.](image)

Studies established that the highest yield is observed in the bryophytic and herb meadow (31.5 dt/ha of dry matter), willow and cereal meadow (38 dt/ha of dry matter), and cereal meadow (41 dt/ha of dry matter).
Research showed that the productivity of tundra meadows is largely determined by the biochemical composition of the fodder [6, 7]. The highest productivity was observed in the willow-and-cereal and cereal meadows: 2698-2891 fodder units, 36.1-38.4 GJ in metabolic energy, and 122-198 kg per 1 ha in raw protein (Table 1).

Table 1. Deer pasture productivity and crop yield.

| No. | Fertilizers                | Yield, dt/ha of dry matter | Production per 1 ha | raw protein kg |
|-----|----------------------------|----------------------------|---------------------|----------------|
| 1   | Cotton-grass and herb meadow | 20.0                       | 19.2               | 1480           | 116            |
| 2   | Bryophytic and herb meadow   | 31.5                       | 27.7               | 1953           | 85             |
| 3   | Willow and cereal meadow     | 38.0                       | 36.1               | 2698           | 122            |
| 4   | Cereal meadow                | 41.3                       | 38.4               | 2891           | 198            |
| 5   | Scheuchzer cotton-grass meadow | 16.3                     | 14.0               | 962            | 138            |
| 6   | Cereal and herb meadow       | 6.5                        | 5.7                | 409            | 40             |
| 7   | Bryophytic and sedge meadow  | 10.5                       | 9.1                | 640            | 39             |
| 8   | Sedge meadow                 | 8.6                        | 7.5                | 542            | 51             |

6. Conclusions
We identified a partial degradation of the vegetation cover of pastures, low content of nitrate nitrogen, active phosphorus, exchangeable potassium, and slight chloride salinity. According to the biochemical composition, the quality of fodder corresponds to classes 2 and 3 in terms of raw protein content.

We determined that deer pastures receive the most damages during fawning (in springtime). This period lasts between late May and early July. During this time, early and late-spring reindeer moss and fresh grass pastures are trampled.

To rationalize the use of tundra and wooded tundra pastures during fawning, we recommend using sparing herd forays with shorter distances (2-3 km) in new cultivated pastures. This will help provide adequate nutrition to fawned reindeer females and preserve newborn fawns.

7. References
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