Improving the forage production system in the Moscow region at the present stage

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Abstract. The studies were conducted on the experimental field of the All-Russian Research Institute of Phytopathology in 2016-2018 in two field experiments on sod-podzolic heavy loamy soils. The aim of the research was to select among the widest range of forage crops the most productive ones with high nutritional value and low cost for organizing green and raw materials conveyors in order to make more rational use of labor and technical resources. Among the annual crops and mixtures, the most productive for three years on average were sunflower, Sudan grass, white lupine and oats: the crop of fodder units was respectively: - 49.9; 50.9; 49.9 and 47.9 centners per hectare; mixtures with peas, they are inferior to single-species crops due to pea damage by powdery mildew and pea weevil, and white sunflower with lupine ensured an equal collection of feed units — 49.9 centners per hectare and the highest provision of digestible protein —127 g in 1 fodder unit. Of the perennial grasses yellow-hybrid alfalfa and timothy grass, which it is expedient to grow in mixed sowing to increase the productive longevity of herbs and reduce the cost of feed, proved to be the most promising.

1. Introduction
The most important task of the agro-industrial complex of the Moscow region is to meet the growing needs of the region for high-quality livestock products, which is largely due to the improvement of the feed production system in the direction of increasing the yield and nutritional value of forage crops, and reducing the cost of feed for effective management of the industry.

Forage crops occupy about 2/3 of the sown area in the Moscow region and represented mainly by perennial and annual grasses for hay and haylage; corn for silage is grown on a small area [1,14]. The combination of dairy farming and crop production on farms of various forms of ownership creates certain prerequisites for a more efficient use of labor and technical resources, improving the economic performance of enterprises, as well as material wealth and social living conditions in the countryside as a whole [18].

When planning the fodder base in farms, it is important to form an optimal herd structure, which provides for artificial insemination in dairy farming with checking of bulls by the quality of offspring, annual rejection of cows during machine milking - 20%, rejection of first-calf heifers when checking - 30% and replacement heifers - 10%, the output of calves per 100 cows and heifers is not less than 90-92, a decrease in calf losses to 1.5-2% [2,3,19].
According to the recommended feeding norms [4], the annual requirement of cows with a milk yield of 6 thousand liters of milk per year with a fat content of 3.8-4% is 6,000 feed units or 6.6 thousand mJ of metabolic energy and 660 kg of digestible protein.

To achieve a productivity of 5-6 thousand kg per year, it is necessary to inflate 17-20 kg per day, and the ration should contain feed with a nutritional value of about 0.85-1 feed units in 1 kg of dry matter of feed or 10-11.5 mJ of metabolic energy, since even highly productive animals cannot consume more than 3.5-4 kg of dry matter of feed per 100 kg of live weight per day or with a weight of 500 kg only 18-20 kg.

The annual demand for feed for cows and first-calf heifers with a productivity of 5-6 thousand kg of milk per year is 50-60 feed units, and for young animals of all ages - 19.6 feed units.

In this regard, the purpose of the field research conducted by us in 2016-2018 on the experimental field of the All-Russian Research Institute of Phytopathology was to study the adaptive potential and the peculiarities of its implementation, depending on the prevailing agro-ecological conditions in the region, for a wide range of annual forage crops and perennial grasses to create highly productive green and raw material lines, increasing the economic efficiency, energy and protein nutritional value of feed and ensuring high productivity in farm animal production.

2. Materials and Methods

The soil on the experimental site is sod-podzolic, heavy loamy. The set of annual forage crops included oats, barley, peas, Sudanese grass, sunflower, white lupine in pure and mixed crops, and perennial grasses: blue and yellow hybrid alfalfa, sandy sainfoin, meadow timothy, meadow fescue, awnless rump in pure wheatgrass and mixed crops. Winter wheat for grain was the forecrop. Agrotechnics included autumn plowing at 20-22 cm, in the spring the spreading of mineral fertilizers 100 kg/ha of Azofoska for pre-sowing soil cultivation BDN-2.2 by 10-12 cm, then sowing was carried out with a pneumatic grain seeder SPU-4 with a row spacing of 12.5 cm, and sunflower - 70 cm, after sowing, they were rolled with 3KKSh-6 rollers.

The sown area of the plots was 200 m² (4×50 m), 4-fold repetition, average green mass samples were dried at t=105°C to determine the percentage of dry basis.

3. Results and Discussion

The yield of crops primarily depends on the prevailing agro-ecological conditions and the degree of their compliance with biological requirements during the entire growing season. The limiting factors of productivity in the Non-Chernozem zone are, first of all, increased acidity and low content of nutrients in the soil, increased soil density and insufficient depth of the arable horizon for normal development of the root system, leaching type of water regime and significant losses and poor digestibility of applied fertilizers due to this.

According to our research (Table 1), the average soil density before harvesting grain mixtures for feed in the 0-20 cm layer was 1.47 g/cm³, the unit weight was 2.56 g/cm³, and the total soil space was 42.6%; in a layer of 0-30 cm, respectively -1.51 g/cm³, 2.55 g/cm³ and 40.8%, which indicates a very low porosity of aeration when capillary pores are filled with water and a decrease in the role of adsorption in plant nutrition due to lack of oxygen for respiration of the roots.

| Soil space, cm  | Humidity, % | Average density, g/cm³ | Unit weight, g/cm³ | Total soil space, % | Soil space of air capacity, % | Water volume in 0-30 cm layer, % |
|----------------|-------------|------------------------|--------------------|---------------------|-----------------------------|---------------------------------|
| 0-10           | 17.8        | 1.45                   | 2.52               | 42.5                | -                           | -                               |
| 10-20          | 16.2        | 1.49                   | 2.60               | 42.7                | -                           | -                               |
| 20-30          | 15.2        | 1.59                   | 2.54               | 37.4                | -                           | -                               |
| 0-30           | 16.4        | 1.51                   | 2.55               | 40.8                | 15.2                        | 25.6                            |
Cultures reacted differently to the prevailing weather conditions by year: 2016 was characterized by the most favorable weather conditions of all 3 years of research. The amount of precipitation in May and June was close to the average annual norm, and in July and August it was 1.5 times higher. The average monthly air temperatures throughout the summer were higher than the average annual temperature by 1.2-2.2°C. The highest yield of dry matter and feed units in single-species crops was provided by sunflower, oats and barley, and their mixtures with peas were inferior due to 100% damage to peas by powdery mildew.

In 2017, the most humid year, the most productive in single-species crops were white lupine, oats and barley: the collection of fodder units in the crop was - 65.8, respectively; 60.1 and 58.7 c/ha, and exchange energy -70.7; 66.8 and 61.9 kJ/ha. Sunflower and Sudanese grass and even peas were inferior to them due to lack of heat.

In 2018, crops with high growth rates in July and August had a noticeable advantage in the yield of feed units: white lupine, sunflower and Sudanese grass, respectively - 60.5; 62.2 and 66.9 c/ha, on which the lack of precipitation in May, June and August was reflected to a lesser extent compared to oats, barley, peas and their mixtures. Peas already in milky ripeness were damaged by the field pea weevil, hence its mixtures were inferior to single-species crops. The yields of crops and mixtures and their nutritional value on average for 3 years of research are shown in Table 2.

The green mass of the studied crops in terms of the concentration of feed units, metabolizable energy in 1 kg of dry matter is fully consistent with livestock standards for achieving high productivity in dairy farming, and in a mixture with legumes and in terms of the content of digestible protein.

| №  | Crop, blend     | Yield of greens, c/ha | % of dry basis | Yield of dry basis, c/ha | Collection of feed units, c/ha | Exchange energy output, kJ/ha | Content of dry basis in 1 kg |
|----|-----------------|-----------------------|----------------|-------------------------|-------------------------------|-------------------------------|-----------------------------|
| 1  | Oats            | 126                   | 42.7           | 53.8                    | 47.9                          | 53.3                          | 0.89                        |
| 2  | Peas            | 129                   | 33.8           | 43.6                    | 38.5                          | 42.1                          | 0.88                        |
| 3  | Barley          | 88                    | 55.7           | 49.0                    | 44.6                          | 47.0                          | 0.91                        |
| 4  | Lupine white    | 231                   | 22.7           | 52.5                    | 49.9                          | 53.7                          | 0.91                        |
| 5  | Sunflower       | 259                   | 23.6           | 61.1                    | 49.9                          | 59.0                          | 0.82                        |
| 6  | Sudanese grass  | 146                   | 56.4           | 53.1                    | 50.9                          | 53.7                          | 0.98                        |
| 7  | Oats + peas     | 128                   | 38.0           | 48.7                    | 43.2                          | 47.7                          | 0.89                        |
| 8  | Barley + peas   | 109                   | 45.1           | 46.3                    | 41.6                          | 44.6                          | 0.89                        |
| 9  | Sunflower + peas| 193                   | 27.1           | 52.4                    | 44.2                          | 50.6                          | 0.85                        |
| 10 | Sunflower + white lupine | 239               | 23.8           | 56.8                    | 49.9                          | 56.4                          | 0.88                        |

On average, over 3 years the highest yield of dry basis, feed units and the yield of metabolic energy in the crop were provided by sunflower, Sudanese grass, white lupine, oats: dry basis, respectively - 61.1; 53.1; 52.5 and 53.2 c/ha, and feed units -49.9; 50.9; 49.9 and 47.9 c/ha.

Mixtures with peas were inferior to single-species crops due to damage by diseases and pests of peas for 2 out of 3 years, but exceeded in terms of the provision of digestible protein [8].

Due to the earlier formation of the crop and harvesting, barley was slightly inferior to them in yield already in the 3rd decade of July, but it can be cultivated in crops to extend the green and raw material line mixed with peas.

In the first decade of August, after barley, Sudanese grass, oats and sunflower with peas ripen for harvesting, in mid-August sunflower mixed with lupine. Sudanese grass in mid-September is able to
form a second cut, which makes it possible to use harvesting equipment and extend the green conve-
yor at the expense of annual forage crops and mixtures for 2 months.

It should be noted the emerging prospects of relatively new forage crops for the zone: Sudanese grass, sunflower and white lupine. At the same time, it is very important to get our own seeds of these crops, the cost of 1 ton of seeds of Sudanese grass and sunflower does not exceed 9-10 thousand rubles. for 1 ton, and lupine 7 thousand at a market price, respectively 25-30.17-20 and white lupine 15 thousand rubles per 1 ton. In addition, under unsuccessful weather conditions for harvesting seeds, crops can always be harvested for forage purposes, essentially without losses.

Sudanese grass is suitable for pasture use in the autumn, which is very important for the exercise of animals with year-round stall keeping.

Perennial grasses play an important role in the organization of the forage base in essentially all soil
and climatic zones due to their high ecological plasticity, productive longevity and forage quality, posi-
tive impact on soil fertility with an urgent need to reduce technological costs due to increased prices
for fuel, fertilizers, etc. means of protection. Perennial grasses in the Non Chernozem zone not only
play a leading role in fodder production, occupying about two-thirds of the sowing of fodder crops, but
are also the main factor in the reproduction of soil fertility [5].

The main areas in the structure of perennial grasses are occupied by clover, timothy and their mix-
tures [6], the disadvantage of which is a short period of use, while the main costs fall on the year of
tinning. The duration of use can be increased by replacing the clover with alfalfa mixed with timothy,
which is characterized by high winter hardiness, durability, regrowth after cutting and good quality.

In contrast to alfalfa sandy sainfoin has a more stable seed production, good honey plant, with-
stands a deeper seeding of seeds when sowing up to 4-6 cm, but quickly falls out of the grass stand
already for 3-4 years [7].

4. Conclusions

For creating a forage base, it is important to expand the most productive crops with high nutritional
value and low cost of forage crops and mixtures for organizing green and raw material conveyors in
order to more efficiently use labor and technical resources:
- among annual forage crops, the most productive on average for 3 years were sunflower, Sudanese
glass, white lupine and oats, the yield of dry matter was, respectively: - 61.1, 53.1, 52.5 and 53.2 c/ha,
forage units - 49.9, 50.9, 49.9, and 47.9 c/ha; mixtures with peas were inferior to single-species crops
due to damage to peas by powdery mildew and pea kernels, but exceeded 100-102 g per 1 feed units in
the provision of digestible protein.
- barley mixed with peas was somewhat inferior in the yield of feed units per hectare, but it can be
cultivated in a green line for early harvesting in the third decade of July; in August, oats mixed with
peas, Sudanese grass in the first cut and sunflower mixed with peas, and then with lupine are alternate-
ly harvested;
- to reduce the cost of forage, it is advisable to harvest Sudanese grass and sunflower for seeds on a
part of the area under favorable conditions: their cost price is half the market price;
- among perennial grasses, promising crops on sod-podzolic heavy loamy soils are yellow-hybrid al-
falfa from legumes, timothy grass from cereal grasses, which are advisable to grow in mixed crops in
the output fields of crop rotations.

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