Alfalfa (Medicago sativa) in forage crop rotations of the forest zone

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Abstract. The forest zone of Russia is most favorable for the development of dairy and meat animal husbandry. In solving the problem of intensification of animal husbandry, the most important role belongs to high-quality feed, especially in terms of their provision with protein and essential amino acids [1, 2, 3, 4]. Alfalfa is of great importance in solving the problem of producing high-quality forage. The expansion of alfalfa sowing in the forest zone is facilitated by successful breeding of varieties at the All-Russian Research Institute of feed (Selena, Pasturenyaya 88, Vega 87, Lada, Lugovaya 67), combining high productivity of biomass and seeds, resistance to unfavorable environmental factors, a positive effect on fertility and nitrogen balance in the soil ... The most fully productive potential of alfalfa, including longevity in nitrogen-fixing capacity, is realized in fodder crop rotations, which are the basis of field fodder production in specialized dairy and meat farms [5].

Keywords: forest zone, alfalfa, forage, forage crop rotations, productivity, technology.

1. Introduction

Studies to study the efficiency of alfalfa cultivation in forage crop rotations were carried out on soddy-podzolic and gray forest well-cultivated soils of the Central Experimental Base and the Moscow Selection Station of the All-Russian Research Institute of Forages [6] in accordance with the guidelines for the development of intensive forage crop rotations [7], guidelines for bioenergetic assessment of crop rotations and technologies for growing forage crops [8]. The productivity of alfalfa was studied depending on the type of crop rotation and the predecessor, with permanent and repeated cultivation, the duration of productive longevity, and the optimal combination of crops in crop rotations.

The soil is soddy-podzolic medium loamy with a humus content of 2.1-2.3%, easily hydrolyzed nitrogen 71-75, P₂O₅ – 310-320, K₂ – 120-125 mg per 1000 g of soil; pH_saline extracts 5.8-6.0, hydrolytic acidity - 1.7-2.5 mEq. per 100 g of soil.

Heavy loamy gray forest soil with a humus content of 2.29-3.0%, easily hydrolyzable nitrogen 110-120, P₂O₅ – 280-295, K₂O – 230-250 mg per 1000 g of soil; pH_saline 5.4-6.0, hydrolytic acidity 3.2-3.5 meq per 100 g of soil.

It has been established that on soddy-podzolic soils, the economically feasible period of alfalfa cultivation in terms of productivity is 3 years, on gray forest soils - up to 4-5 years. With an increase in the terms of use of alfalfa crops, the defeat of ascochitosis (Ascochyta), brown spot (Pseudopeziza) and root rot (Fusarium, etc.) significantly increases, which leads to thinning of the herbage. With an increase in the terms of use of the herbage, the number of weeds also sharply increases, mainly creeping couch
grass (Elytrigia repens L.) and medicinal dandelion (Taraxacum officinale). In the green mass of affected plants, the content of crude protein, carbohydrates, carotene decreases, and, consequently, the quality of feed [9].

Re-cultivation of alfalfa in monoculture did not lead to the restoration of the productivity of its crops. In the first year of use, the productivity of re-seeding was less by 31%, in the second - by 9%, and in the third - by 49% compared to the crop rotation (Table 1).

| Table 1. Productivity of alfalfa and awnless rump during re-cultivation and in crop rotation |
| --- |
| Culture | Growing conditions | Collection of dry matter, c / ha | |
| | | 1 | 2 | 3 | average |
| Alfalfa | repeatedly | 42,0 | 61,3 | 28,4 | 43,9 |
| | in crop rotations | 60,9 | 67,2 | 55,5 | 61,2 |
| awnless rump | repeatedly | 70,2 | 66,5 | 57,1 | 64,6 |
| | in crop rotations | 77,4 | 81,7 | 55,5 | 71,5 |

Compared to alfalfa, awnless rump (Bromopsis inermis), in terms of productivity, reacted less to repeated sowing.

Thus, effective cultivation of alfalfa is possible only in a crop rotation system, including hatching fields. According to the generalized data, the time of return of alfalfa to its former place in the crop rotation is approximately equal to the duration of the use of its crops. On sod-podzolic and gray forest soil, with 3-4 years of herbage use, it should be returned to its original place not earlier than 3-4 years, and the number of fields in the crop rotation should be seven to eight. Corn tolerates repeated crops well and does not reduce productivity for 6-7 years.

In comparison with awnless rump, the productivity of annual crops placed on the alfalfa layer was significantly higher, which is associated with the favorable influence of the culture on the nitrogen nutrition regime (Table 2).

| Table 2. Influence of the layer of alfalfa and awnless rump on the productivity of subsequent crops (on average over 7 years) |
| --- |
| Culture | Lucerne 3 g.. | Awnless rump 3 g.. |
| | dry matter, c / ha | protein, kg / ha | dry matter, c / ha | protein, kg / ha |
| Winter erysipelas s / feed | 25,8 | 365 | 22,8 | 299 |
| Corn cuttings | 69,7 | 661 | 63,8 | 580 |
| Silage corn | 103,4 | 905 | 93,3 | 830 |

The positive influence of the alfalfa layer on the productivity of subsequent crops has been noted for three years.

More favorable conditions for the growth and development of alfalfa were noted when alternating with maize. When placed in the link of annual corn crops, the safety of alfalfa plants was higher, and the productivity of its crops by years of use was also higher. On average, over seven years of research, the collection of dry matter of alfalfa when placed in the link of annual corn crops was 6.4 centners / ha or 10-11% higher compared to the link where winter rye was cultivated for green fodder, fodder beet and corn (Table 3).
Table 3. The productivity of alfalfa in herb-row crop rotations depending on the species composition of the link of annual crops (average over 7 years)

| Crop rotation | Link of annual crops | Collection of dry matter of alfalfa, c / ha |
|---------------|----------------------|------------------------------------------|
|               |                      | 1     | 2     | 3     | average |
| Grass-cultivated alfalfa | winter rye for feed, corn for harvest - fodder beets - corn | 57,2   | 60,2   | 47,0   | 54,8    |
| Grass-cultivated alfalfa | - corn - corn - corn | 60,3   | 63,1   | 60,0   | 61,1    |

Consequently, alfalfa and corn, when they alternate, show a positive interaction on their productivity and the productivity of the crop rotation area as a whole.

The ratio of maize and alfalfa fields is also determined by the quality of the voluminous forage produced, and, above all, by the protein content. According to long-term studies of the Moscow selection station of the All-Russian Research Institute of Forage [9], crop rotations with an equal number of fields of corn and alfalfa are more effective. So, in a crop rotation with a ratio of maize and alfalfa fields of 4:4, the yield of fodder units per hectare was 94 centners, of digestible protein was 960 kg, and the supply of 1 fodder unit with digestible protein was 102 g. units decreases by 9-11%, while the digestible protein increases by only 4%. The cost of a fodder unit in the third crop rotation is about 2% higher than in the second (Table 4).

Table 4. Productivity of arable land and the provision of a feed unit with protein depending on the structure of the sown area (on average over 10 years)

| Crop rotation number | Crop rotation scheme, structure sown area | Exit from 1 hectare | Security 1 unit. Protein, g |
|----------------------|------------------------------------------|---------------------|-----------------------------|
|                      |                                          | feed units, c | digestible protein, kg      |
| I                    | 1) corn with over-sowing of alfalfa, 2-4) alfalfa 1-3 g., 5-8) corn (alfalfa 38%, maize 62%) | 96     | 880   | 92   |
| II                   | 1) corn with alfalfa overseeding, 2-5) alfalfa 1-4 g., 6-8) corn (alfalfa 50%, maize 50%) | 94     | 960   | 102  |
| III                  | 1) corn with over-sowing of alfalfa, 2-6) alfalfa 1-5 g., 7-8) corn (alfalfa 62%, maize 38%) | 85     | 1000  | 118  |

Schematic diagrams of alfalfa-corn crop rotations recommended for production:

On sod-podzolic soils
1) corn for green fodder or vetch-oat mixture with over-sowing of alfalfa, 2-4) alfalfa 1-3 g., 5-7) corn.

On gray forest soils, podzolized and leached chernozems
1) corn for green forage with over-sowing of alfalfa, 2-5) alfalfa 1-4 g., 6-8) corn for silage.

In large farms, alfalfa-corn crop rotations should be introduced in combination with pastures near complexes and farms for the production of milk and meat. This arrangement can significantly reduce the cost of transporting plant materials, organic fertilizers and other materials. If necessary, cereals and other crops can be introduced into the row-crop link.

In some cases, alfalfa-corn crop rotations can be deployed only in time on 2 fields with alternate cultivation of crops:
1) alfalfa for at least 3-4 years of use
2) corn reused for at least 3-4 years.

With such an alternation and favorable conditions for the functioning of herbage in the first years of life, alfalfa can be used for a longer time than the recommended one.
On the soils of insufficient cultivation in the initial period of the development of crop rotations, instead of single-species alfalfa crops, it is possible to cultivate grass mixtures consisting of alfalfa, awnless rump, meadow timothy or alfalfa, meadow clover and meadow timothy. It is better to sow such mixtures under the cover of the vetch-oat mixture.

The main advantages of alfalfa-corn crop rotations are:
- the minimum species composition of crops, allowing to organize a less complex system for the production of high-quality feed with a minimum of agrotechnical and technological solutions, a high return on material and technical resources;
- intensive use of arable land at a low cost of feed balanced in energy and protein. The average yield of fodder units per 1 ha of arable land is on average 55-60 on sod-podzolic soil, on gray forest soil 80-90 centners, the content of digestible protein per 1 fodder unit is 104-114 g, the cost of 1 centner of forage units 420-480 rubles;
- sowing alfalfa under corn or vetch-oat mixture, which provides favorable conditions for its growth and development in the 1st and subsequent years of life due to weak competitive relations between crops, suppression of weeds, pests and diseases in the row-crop link with corn;
- effective restoration of soil fertility in the grass field link of crop rotation by biological methods. On sowing alfalfa of the third year of use, more than 100 centners / ha of dry matter with plant residues, which contain up to 165 kg of nitrogen, enter the soil;
- biological nitrogen of the soil is intensively consumed by corn plants, which eliminates the pollution of groundwater with nitrates and reduces the need for this crop in mineral nitrogen fertilizers. The average consumption of mineral nitrogen in the row-crop link with corn does not exceed 100-120 kg / ha.

Overseeding of alfalfa under the cover of corn is very effective for the formation of full-fledged alfalfa grass stands and has been successfully used for a long time at the Moscow selection station of the All-Russian Research Institute of Forage. Alfalfa in the first year of life requires good light and moisture supply, which are provided with the slow development of corn in the first half of the growing season. At the same time, in optimal years, alfalfa under cover reaches the flowering phase, and its share in the total crop with corn can be up to 30-40%.

Overseeding of alfalfa under maize is carried out separately in the first half of May: first, maize is sown, and then alfalfa is sown across the rows. With sufficient soil moisture, sowing of alfalfa can be carried out on the corn seedlings. The sowing of corn is wide-row, with the rate providing the formation of 130 to 150 thousand / ha of plants. Alfalfa is sown with grain-herb seeders at the recommended rates; seeding depth of 1.0-1.5 cm. Nitrogen rates for cover crops should not exceed 90 kg / ha a.u., so as not to reduce the level of nitrogen fixation of alfalfa in the first and subsequent years of life. Weed control is carried out mainly in the row-crop link of the crop rotation; when the field is infested with alfalfa over-sowing, herbicides recommended for crops of perennial leguminous grasses are used.

Cover corn is harvested at the end of the third decade of July - until August 10-15. Alfalfa by this time, and the subsequent growing season, forms grass stands that are well preserved in winter. The plant mass of maize is used mainly for green fodder or for the preparation of silage, which is fed in the autumn.

In the tilled link of the crop rotation, predominantly early- and mid-season hybrids of corn are cultivated in order to obtain green mass with cobs of milky-wax ripeness and high quality silage.

Thus, the created adaptive varieties and developed technologies make it possible to significantly expand alfalfa sowing in the forest zone of the European part of Russia. One of the promising areas of intensification is the placement of crops in alfalfa-corn near-farm crop rotations of specialized livestock farms. The introduction and development of such crop rotations makes it possible to produce high-quality forage at a low cost, to reduce the need for high-protein feed additives and nitrogen fertilizers, and to reduce the cost of reproducing soil fertility.

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