RESOURCE-SAVING CULTIVATION TECHIQUES OF FORAGE CROPS UNDER REPUBLIC SAKHA (YAKUTIA) CONDITIONS

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This article describes results of research project regarding application resource-saving cultivation technologies that took place from 1996 to 2014. Experimental works on scientific fundamental of forage crop cultivations in Central Yakutia's crop rotation were performed in research and development center "Yil'gellekh" of "Pokrovskoye" enterprise from 1996 to 1999. Studies on resource-saving tillage technologies were carried out in "Myundulakh" of Megino-Khagnalasskyi district of Republic Sakha (Yakutia) in 2009-2014. Following regionalized crops have been used for the seedings: crop rotation 1- oat, peas-rapeseed, winter rye- winter rye, melilot; melilot 2 years, spring rapeseed-alfalfa-choppy grass (output field); crop rotation 2- melilot-melliot, winter rye- winter rye, oat- rapeseed- Siberian wheatgrass (hatching field). Fertilizes used in study were: 1. No added fertilizer (control); 2. Mineral ferltilizer ($N_{235}P_{60}$); 3. Organic-mineral fertilizer ($manure_{60t/he}+N_{60}P_{60}K_{60}$).

Previous studies showed that [6] adaptive crop rotation 1 and 2 contributed to the increase in yield under organic-mineral fertilizer background with energy efficiency coefficient 1,33-1,28. Yield per 1 hectare of crop rotation filed was 24,7 and 22,4 tons of green mass; output of feeding units 3,69 and 3,47 tons, digestible protein 0,73 and 0,69 t , gross energy 97,9 and 95,4 GJ, exchange energy 49,7 and 48,4 GJ respectively. Organic-mineral fertilizer ($manure_{60t/he}+N_{60}P_{60}K_{60}$) was shown to increase the productivity by 31,7-54,4% and mineral ($N_{235}P_{60}$) by 26,0-46,1% comparing with control (no fertilizer added). In so doing, protein nutrition value as

shown to increase by 21% and 26% respectively. Sowing melilot and alfalfa-choppy grass mix was shown to accumulate higher amount of root residues (12,0 and 12,6 t/ha) aiding to maintenance of the organic matter in soil (+1,0 and 0,9t/ha).

Agrochemical composition of taiga-pale permafrost soil in studied ares "Myundulakh" was following: pH alkaline, water pH -8,16-8,29; humus content in upper horizon- 2,89%; content of nitrogen moving form Nnitr- 0,17%; moving form P20%- 16,4; K2O5- 29,7 mg/100g. The following techniques were examined: 1. plow tillage (traditional technology); 2. Resource-saving technology based on the Ob-4-ZT; 3. Resource-saving technology based on the SZS-4.2 aggregates. The studied culture was an oatmeal mixture. The use of integrated resource-saving aggregates on permafrost soils provided the green mass yield of 103.9 -105.7 c / ha. In comparison with traditional processing the yield of green mass of oatmeal mass increased by 13.7 - 15.5 c / ha.

Key words: *crop rotation, adaptive forage crops, mineral and organic fertilizers, productivity, yield, soil processing, green mass*

Introduction

In Yakutia, the development and implementation of resource-saving agrotechnological techniques revolves around adapting to particular soil composition and climatic characteristics. The abundance of solar radiation is getting particular interest. The total sum of active temperatures above 10°C in the Prilensky agro-landscape equals to 1464°C, which is sufficient for growing forage crops with a short growing season for green mass [1].

Silage and haylage making has always been one of the main tasks in fodder crop production. The main goals are to develop scientifically based crop rotation method, including raising the agrarian culture, increasing permafrost fertility and in overall increasing its fodder crops production.

In recent times, researchers have been developing methods of strengthening of crop production depending on the financial and resource supply of farms at various levels, considering their economic feasibility as well as environmental restrictions. This practice in general can be defined as resource-saving technologies.

The most crucial issues in this matter are the utilization of the up-to-date agricultural production technologies, technical re-equipment of production, increased labor productivity, reduced production costs and increased product realization volumes. Prospects in reducing and combining technological activities in the soil tillage system are strongly associated with the overall transition to combined tillage sowing machines that are able reduce the entire sowing cycle to the one or two technological methods.

Materials and methods

Experimental works on scientific fundamentals in forage crop tillage at Central Yakutia crop rotations took place in research and development center "Yil'gellekh" of "Pokrovskoye" enterprise at 1996-1999. Years of study were considerably different by its meteorological conditions. Hydrothermal coefficient during vegetative period was 1,29; 0,69; 0,30; 1,19 by every year respectively; average was 0,60.

The soil of the experimental plot is meadow-chernozemic, slightly saline. Soil salinity is chloride-sulfate type with Cl_2/SO_4 ratio: 0-40 cm- 0.76; 40-60 cm-0.71; 60-80cm- 0.67; 80-100cm -1.15 mg-equals per 100 g of soil. Soil salinity was determined according to Elovskaya gradation chart [2].

According to data from 1996, agrochemical characteristics at the initial stage were in following: alkaline reaction pH saline- 7.7-8.3; the humus content - (as of Tyurin) - 5.4%, the content of mobile forms of nitrogen is average: N_{nitr} - 0.89 (by Grandval-Lyazhu method); the content of phosphorus mobile forms is average: P_2O_5 - 13.3; potassium content (Egner-Rome method)is high: K_2O - 19.2 mg / 100 g of soil.

Agricultural technology of fodder crops (sowing dates, seeding rate, tillage, etc.) was performed according to the recommendations of YNIA for fodder crops [3]. Of the mineral fertilizers, urea (46% active component (a.c.)), double superphosphate (46% a.c.) and potassium chloride (60% a.c.) were used. From organic fertilizers, manure was used and introduced at the beginning of rotation at the content of 60t/ha.

Regional varieties of seeds were used for spreading fodder crops: variable wheatgrass (Lenskaya variety), white clover (Nemyugyunsky variety), oats (Pokrovskiy variety), peas (Capital variety), spring rape (East Siberian variety), winter rye (Sitnikovskaya variety) , Siberian wheatgrass (variety Kamalinsky 7), yellow alfalfa (variety Yakutsk).

Irrigation was carried out via DDN-70 with a norm of 400 m^3/ha at 2–3 times during the vegetation season with a below 60% decline in the lowest soil moisture capacity (1997, 1998).

The experimental design included the study of 2 five-field crop rotations.

Crop rotation 1. Oats, peas - rapeseed, winter rye - winter rye, melilot; - melilot 2 years, spring rapeseed - alfalfa + chopped grass (hatching field).

Crop rotation 2. Clover - clover, winter rye - winter rye, oats - rapeseed - Siberian wheatgrass (hatching field). Fertilizer types used were: 1. No added fertilizer (control); 2. Mineral ferltilizer ($N_{235}P_{60}$); 3. Organic-mineral fertilizer ($manure_{60t/he}+N_{60}P_{60}K_{60}$). Area of experimental plot was 90m^2, plot areas were 30m^2 divided by the fertilizer type. Localization was randomized, as well as experiments were replicated three times. Total area covered for experiments was 1 hectare.

Observation and calculations were carried according to recommendations from Research Institute of Forages [4]. Agrological energy values were calculated also following to recommendation established by Research Institute of Forages.

Results and discussion

The highest productivity throughout the studied years was observed in pea-oat mix, melilot and rapeseed crops. The pea-oat mix dominated other studied crops by dry mass output 4,22t/ha and exchange energy 38,0GJ/ha. However, it was inferior to melilot and alfalfa + chopped grass with digestible protein content of 0.46 t /ha. The yield of green mass was 16.9, with fodder units - 2.95 t / ha. The melilot of the 2nd year provided the highest amount of digestible protein from 1 ha, which was 0.53-0.58 t / ha. The green mass yield was 12.3-13.3, dry weight - 2.95-3.19, feeding units - 2.18-2.36 t /ha, exchange energy - 29.6 GJ /ha. The highest green mass yield was observed in rapeseed - 18.6-22.3 t/ha, while the yield of dry weight was 2.41-2.90, feed units - 1.66-2.01, digestible protein - 0.37- 0.44 t / ha, exchange energy - 22.7-26.5 GJ / ha. The addition of rapeseed as a sloping crop after the second year melilot showed that the green mass yield varies over the years depending on soil moisture. In 4 years, the average of the green mass total yield was 26.0; dry weight - 4.84; feed units - 3.50; digestible protein - 0.83 t /ha, exchange energy - 44.1 GJ/ha.

The yield of green mass of alfalfa + variable wheatgrass was 12.8; feed units - 2.50; dry weight - 3.58; digestible protein - 0.59 t/ha. The exchange energy was 32.0 GJ / ha.

Over the years of research, it was founded [6] that adaptive crop rotation 1 and 2 ensured higher productivity against the background of organic-mineral fertilizer with an energy efficiency coefficient of 1.33-1.38. Green mass yields per 1 ha of crop rotation area were 24.7 and 22.4 tons, respectively. Yield of feed units were 3.69 and 3.47 tons, digestible protein 0.73 and 0.69 tons, gross energy 97.9 and 95, 4 GJ, exchange energy 49.7 and 48.4 GJ, respectively. Organic and mineral fertilizer (manure 60t/ha + $N_{60}P_{60}K_{60}$) increased yield by 31.7-54.4%, mineral fertilizer ($N_{235}P_{60}$) by 26.0-46.1% compared to control. At the same time, the protein nutritional value of feed crops increased by 21 and 26%, respectively. The cultivation of sweet clover and alfalfa – chopped grass mix provided the highest accumulation of root residues (12.6 and 12.0 t/ha) among other varieties, which helps to maintain the balance of organic matter in the soil (+1.0 and 0.9 t/ha).

Studies on the use of resource-saving soil cultivation technologies were carried out in "Mundulah" site of the Megino-Kangalassky district in 2009-2014. The agrochemical composition of the permafrost taiga-fawn soil of the experimental plot was following: the medium was alkaline, with aqueous pH -8.16-8.29; the humus content in the upper horizon is 2.89%; content of mobile forms of nitrogen - 0.17%; mobile forms of P_2O_5 - 16.4; K_2O_5 - 29.7 mg / 100 g.

The scheme for semi-production experiment is listed below:

1. Plow tillage (traditional technology);
2. Resource-saving technology based on the Ob-4-ZT;
3. Resource-saving technology based on the SZS-4.2.

Experiment was replicated 3 times. The plot area was 0.5 hectares, with the experience area is 3.0 hectares. Crops used in this experiment was vetch-oat mix.

According to phenological and biometric observations, more optimal conditions for the growth and development of plants in the conditions of resource-saving technology were observed. In traditional tillage, the onset of phenological phase in crops was accelerated. Furthermore, the height of the plants was slightly lower than in those produced by resource-saving tillage. The combined use of green manure steam and multi-functional complex machines (APC type-5.7, Ob-4-3T), was shown to improve the agrophysical properties of soils, preserved and as well as restored the fertility properties in soil. This method also accelerated the decomposition process (due to enhanced soil aeration) and the accumulation of organic matter in the permafrost zone.

The application of integrated resource-saving aggregates on permafrost soils facilitated to production of green mass yield of 103.9 -105.7 c/ha. In contrast with the traditional processing, an increase in the oatmeal green mass yield was 13.7 - 15.5 c/ha (Table 1). Plant height reached: in oats 77.3cm; vetch- 59.7 cm, with traditional processing. As for crops in produced by resource-saving technology the plants height reached up 92.0, 64.7 cm, respectively.

Table 1

Yield of vetch-oat green mass, t/ha (2009 – 2013 y.).

Variant	Years					Average	Increase
	2009	2010	2011	2012	2013		
Traditional tillage	70,0	58,6	119,0	-	113,0	90,2	-

Resource-saving technology(Ob-4-ZT)	7,0	66,7	133,0	-	146,0	105,7	15,5
Resource-saving technology(O SZS-4.2)	75,0	58,7	147,0	-	135,0	103,9	13,7

HCP_{05} – 2,48

Practical application of multifunctional techniques and complexes ensured [7]:

- reduction of energy consumption by 1.5 - 2.0 times in comparison with traditional technology and increasing the overall productivity by 1.5 - 1.8 times;
- moisture preservation in permafrost soils is 20-25% higher than in ones that were produced via the recommended regional soil treatment technologies;
- improvement of agrophysical properties as a result of a decreased soil density (volumetric mass of the soil according to the recommended regional tillage technologies was 1.23 g/m³, with resource-saving processing - 1.18 g/m³);
- a 2-fold increase in the number of microorganisms in the soil in a layer of 0-20 cm from 120.8 million per gram. soil with regional processing technology, up to 232.0 million per 1 g of soil;
- the value of the use of total water consumption per unit of crop with resource-saving soil cultivation technology was 105.5 mm (when processing by regional technology - 91 mm).

Conclusion

Taken all together, our long-term research project showed that utilization resource-saving technologies with elements of an adaptive farming system for field feed production increase the productivity of crop rotation, contribute to the preservation of productive moisture and the balance of organic matter in the soil.

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