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ECONOMIC EVALUATION OF MECHANIZED TECHNOLOGIES FOR THE PREPARATION OF LIVESTOCK FEED BASE

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ABSTRACT

The use of natural forages in Georgia is currently the only priority, namely, from tens of thousands of hectares unsuitable for arable land, it is possible to obtain livestock feed in the form of milk, meat, eggs, wool and honey. Today, much attention is paid to the preparation of roughage and the energy efficiency of machines, the determination of technical and economic indicators for traditional, intensive and high-tech machine complexes. The scientific article discusses the general technical and economic assessment of traditional, intensive and high-tech systems and machine units, in particular, fuel, metal consumption and labor costs. Classifiers of modern machine systems were used to assess the technical and economic indicators of various types of agricultural machinery, and for the purpose of economic assessment, the working schemes of machines for the fundamental and superficial improvement of the species composition of the grass cover are presented. Taking into account the soil conditions of Western Georgia, the economic parameters of individual machine systems were calculated.

KEYWORDS

Machine, Food Processing Plants, Technologies, Economic Evaluation, Combined Machines

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Introduction

In many regions of Western Georgia, where the amount of arable land is small, natural pastures are an almost indispensable and reliable source of high-quality food production.

In addition to the above, these settlements are located in the border region, and therefore their reasonable use is of national importance in terms of securing the population in the mountains (Katsitadze J.2017).

The current extensive system of natural grassland and pasture use, improper use, overgrazing, and neglect lead to reduced yields, deterioration of grassland, decomposition of the cord, and the initiation of erosion processes.

Some species that make up the cenosis cannot withstand competition and fall from the grassland, which leads to species impoverishment, and consequently, the nutritional value of the meadow and the quality of the food obtained decrease.

In the process of fundamental transformations in agriculture and the transition to a market economy, the structure of the food base and food balance has significantly changed, food production on arable land has sharply decreased, and the share of food produced on natural food reserves in the overall food balance has significantly increased.

Based on the above, practical issues of field-meadow forage production should be discussed and studied in a new way, the need for improvement of individual pasture arrays, their location, scale, their root and surface improvement systems and constituent measures, the widespread introduction of the latest technologies, systems for the rational use of hayfields, etc. should be specified and clarified.

The production of food crops should increase significantly in the near future and, given their still untapped potential, at least double.

The average yield of natural pastures per hectare is 1.2-1.4 tons of hay, productivity is 540-680 feed units, the productivity of summer pastures is 490-550 feed units (winter pastures - 230-260 feed units).

From natural meadows and pastures, with appropriate measures for improvement and proper use, it is possible to obtain 3.5-4.5 tons of hay from one hectare of natural meadow, and 2.5-3.5 thousand feed units from pasture.

It is noteworthy that natural grassland produced under a rational system of improvement and use is characterized by high productivity, completeness, and, most importantly, low cost, along with increased yields.

An important reserve for food production is the increase in the yield of natural forages and the introduction of rules for their rational use, as well as the creation of cultural pastures - especially on irrigated lands (Katsitadze J.2017).

According to the data of the Statistical Department of Georgia, natural pastures and meadows in Georgia occupy 1911.2 thousand ha, of which 143.0 thousand ha are meadows, 1768.2 thousand ha are pastures. These pastures are located in the lowland, lower mountain, middle mountain, subalpine and alpine zones.

Due to the low yield of natural pastures, farms cannot fully utilize the great potential for increasing food production that can be achieved as a result of measures to improve significant areas of natural pastures. In the first year of implementation, the costs incurred can be repaid 1.5-2 times or more.

Due to improper use and neglect of forage crops, the area of hayfields is gradually decreasing from year to year, meadows are covered with shrubs, sedges, become swampy, and other negative processes occur that hinder the performance of mechanized work.

Pasture areas are often overcrowded (especially winter pastures), with most of their areas covered with poisonous, harmful, and inedible grasses.

In highland pastures, the weed plant *Nardus* occupies more than 100 thousand hectares, *Veratrum lobelianum* Bernh – 19 thousand hectares, while *Alchemilla* occupy 322 thousand hectares, other non-native plants occupy 37 thousand hectares, etc. (This is data from before 2020. Currently, the situation has worsened even further).

In order to create a strong food base for livestock, along with field forage production, the improvement of natural pastures and their rational use is an urgent task.

Research Methodology

For a generalized technical and economic assessment of traditional, intensive, high-tech and machine-equipment complexes of food production, the following indicators were selected: labor costs; fuel costs; metal consumption and specific energy costs.

For technical and economic evaluation, a block modular system is presented for the production of various technological processes, and the following components should be considered during the production of food crops (Malakhov A. V., Borisov A. A. 2021)

Aggregate productivity per hour

$$W_{Prod} = W_{shift} / \tau_{shift} \text{ G/time} \quad (1)$$

Shift time utilization rate

$$\tau_{shift} = \frac{\tau_1}{1 + \tau_1 + \tau_2 + \tau_3 + \tau_4} \quad (2)$$

Where τ_1 - There is a coefficient that does not depend on the distance of the mode and the speed of the car.

τ_1 - Time spent on return, τ_2 - Technological process time cost, τ_3 - Waste of time on technical support, τ_4 - Time to transfer the unit from transport to working condition (Subaeva A. K 2015)

Fuel consumption per hectare

$$q = \frac{G_n}{W_{cl}} (\lambda_{cl} + \lambda_{mobr} \tau_{mob} + \lambda_{soil} \tau_{soil} + \lambda_{Tech.ser} \tau_{Tech.ser} + \lambda_{transm.} \tau_{transm.}) \text{ kg/h} \quad (3)$$

Where G_n - Nominal fuel consumption

λ_{cl} - Fuel consumption in working mode

Energy costs of processing per unit area

$$E = E_1 + E_2 + E_3 + E_4 \text{ m.j/h} \quad (4)$$

Where E_1 - Direct energy consumption

E_2 - Living labor cost

E_3 - Expenses on tractors

E_4 - Expenditure on agricultural machinery.

Direct cost

$$E_{Dir} = G_t \alpha_{cal}. \quad (5)$$

Where G_t - is the specific fuel consumption cost

α_{cal} - Fuel calorific value

The standard energy consumption of living labor is based on working conditions (heavy, medium, light and very light).

$$E_{stand} = \frac{n \alpha_1}{W_{Agreg}} \quad (6)$$

Where n - Number of workers

α_1 - Energy equivalent cost of manpower

W_{Agreg} - Aggregate productivity

Tractor power capacity

$$E_{tr} = \frac{\alpha_{tr} M_{tr}}{100W_{agreg}} \left(\frac{a_1 + a_2}{T} \right) \tag{7}$$

Where - α_{tr} -is the energy equivalent of 1 kg of tractor mass

M_{tr} -Tractor weight (kg)

$a_1 + a_2$ - Annual charges and deductions for repairs (%)

T - Standard annual tractor load (ha)

Energy efficiency of agricultural machinery

$$E_{mash} = \frac{\alpha_{mash} M_{mash}}{100W_{agreg}} \left(\frac{a_1 + a_2}{T} \right) \tag{8}$$

Where - α_{mash} -is the energy equivalent of 1 kg of tractor mass

M_{mash} -Car weight (kg)

$a_1 + a_2$ - Annual charges and deductions for repairs (%)

T - Standard annual vehicle load (ha)

Results and Discussion

Forage and pastures are improved by using high-quality seeds, applying full doses of balanced mineral fertilizers, and providing the necessary water.

Traditional technologies are considered to be the use of single-operation tractors, machines with passive working bodies, as well as self-propelled combines.

Intensive technologies are considered to be the use of tractors and single-operated machines with active working bodies, as well as self-propelled combines or trailers for harvesting.

High-intensity technologies are considered to be the use of machine-tractor equipment, combined tillage, harrowing and seeding machines, pest, disease, and weed control, and self-propelled harvesters.

The following indicators were selected for the economic evaluation of machines with traditional, intensive and high-intensity technologies intended for the production of food crops: labor costs; fuel costs; metal consumption and specific energy costs.

The improvement of natural habitats was discussed according to the following scheme:

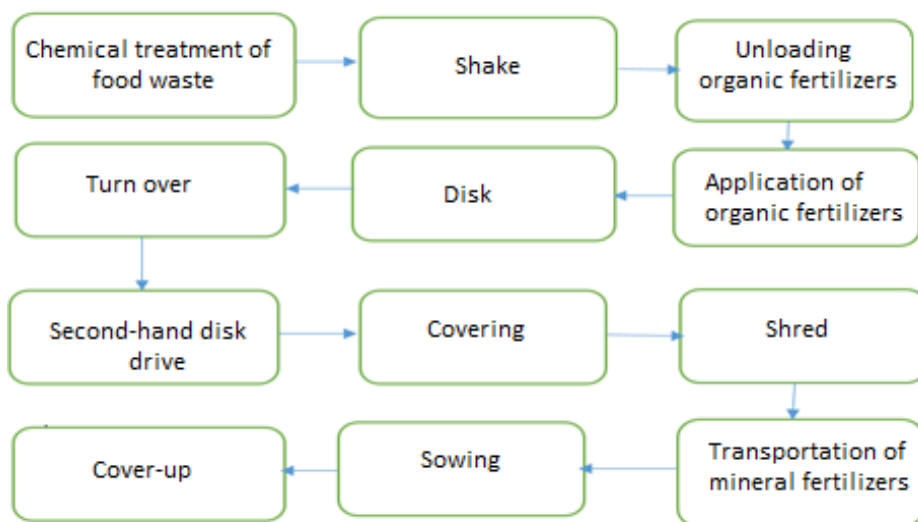


Fig. 1. Scheme of the technology for radical improvement of forage lands

Traditional, intensive, and high-tech work operations were calculated and presented in tabular form.

Table 1. Traditional technology work operations

Traditional technology for improving nutrient soil			
Operation	Aggregate composition	Productivity (hours/hectare)	Fuel consumption (kg/hectare)
	Tractor, type of machine		
Chemical treatment of heavy waste	Tractor Kubota M6060 Sprayer 3WPX-400-8	4,0	2,3
Liming	Tractor Chalion-1002 HP, Dispersant Rup-8	1,70	6,1
Loading of organic fertilizers	Tractor Kubota M6060	3,1	2,9
Transportation and application of organic fertilizers	Tractor Kubota M6060 Dispersant Rup-8	0,18	50
Disk	Tractor Chalion-1002 HP, Disc plow FKMODH -22-12	2,0	4,9
Plowing by turning the soil	Tractor Kubota M6060 Plow 1L-220	1,2	8,0
Second-hand disk drive	Tractor Chalion-1002 HP, Disc plow FKMODH -22-12	2,0	4,9
Lynx	Tractor Kubota M6060 Toothed lynx SH5	1,2	8,7
Transfer	Tractor Kubota M6060 Roller SV544TF84	3,4	2,8
Transportation of mineral fertilizers and seeds	Tractor Kubota M6060 Trailer DEF-ID	2,6	3,8
Spreading mineral fertilizers	Tractor Chalion-1002 HP, Seeding machine MC - 3000 - 18	4,0	3,0
Covering crops	Tractor Kubota M6060 Roller SV544TF84	3,4	2,8

Table 2. List of intensive technology work operations

Intensive technology for improving nutrient soil			
Operation	Aggregate composition	Productivity (hours/hectare)	Fuel consumption (kg/hectare)
	Tractor, type of machine		
Chemical treatment of heavy waste	Tractor Kubota M6060 Sprayer 3WPX-400-8	4,0	2,3
Liming	Tractor Chalion-1002 HP, Dispersant Rup-8	1,70	6,1
Loading of organic fertilizers	Tractor Kubota M6060	3,1	2,9
Transportation and application of organic fertilizers	Tractor Kubota M6060 Dispersant Rup-8	0,18	50
Soil milling	Tractor Chalion-1002 HP Milling cutter DFL-135	1,2	17,5
Transfer	Tractor Kubota M6060 Roller SV544TF84	3,4	2,8
Transportation of mineral fertilizers and seeds	Tractor Kubota M6060 Trailer DEF-ID	2,6	3,8
Spreading mineral fertilizers	Tractor Chalion-1002 HP, Seeding machine MC - 3000 - 18	4,0	3,0
Covering crops	Tractor Kubota M6060 Roller SV544TF84	3,4	2,8

Table 3. List of high-tech technology work operations

High-tech technology for improving nutrient soil			
Operation	Aggregate composition	Productivity (hours/hectare)	Fuel consumption (kg/hectare)
	Tractor, type of machine.		
Chemical treatment of heavy waste	Tractor Kubota M6060 Sprayer 3WPX-400-8	4.0	2.3
Liming	Tractor Chalion-1002 HP, Dispersant Rup-8	1,70	6,1
Loading of organic fertilizers	Tractor Kubota M6060	3.1	2,9
Transportation and application of organic fertilizers	Tractor Kubota M6060 Dispersant Rup-8	0,18	50
Transportation of mineral fertilizers and seeds	Tractor Kubota M6060 Trailer DEF-ID	2,6	3,8
Milling and compaction, grass seeding, mineral-organic fertilizer application, mulching	Combined machine AGRATOR COMBI 4200	7,8	6,5

We have presented the technical and economic indicators of various technologies for improving livestock husbandry in the form of a table.

Table 4. Technical and economic indicators of various technologies

Indicator	Traditional technology	Intensive technology	High technology
Yield in tons/hectare	1,9	3,2	4,6
Labor cost. Man/hour			
1 hectare	10,1	8,5	6,91
1 ton	5,1	2,3	1,54
Fuel consumption kg			
1 hectare	100,3	95,2	70,2
1 ton	50,7	25,2	15,2
Metal capacity kg			
1 hectare	65,2	52,0	42,9
1 ton	33,4	16,1	9,5
Energy consumption megajoules			
1 hectare	11985,1	10706, 8	8525,7
1 ton	5980,2	3058,2	1896,8
Energy efficiency ratio	2,1	6,1	10,1

For various technological processes, we presented the technical and economic parameters for labor costs, fuel costs, material capacity, and energy costs in the form of graphs.

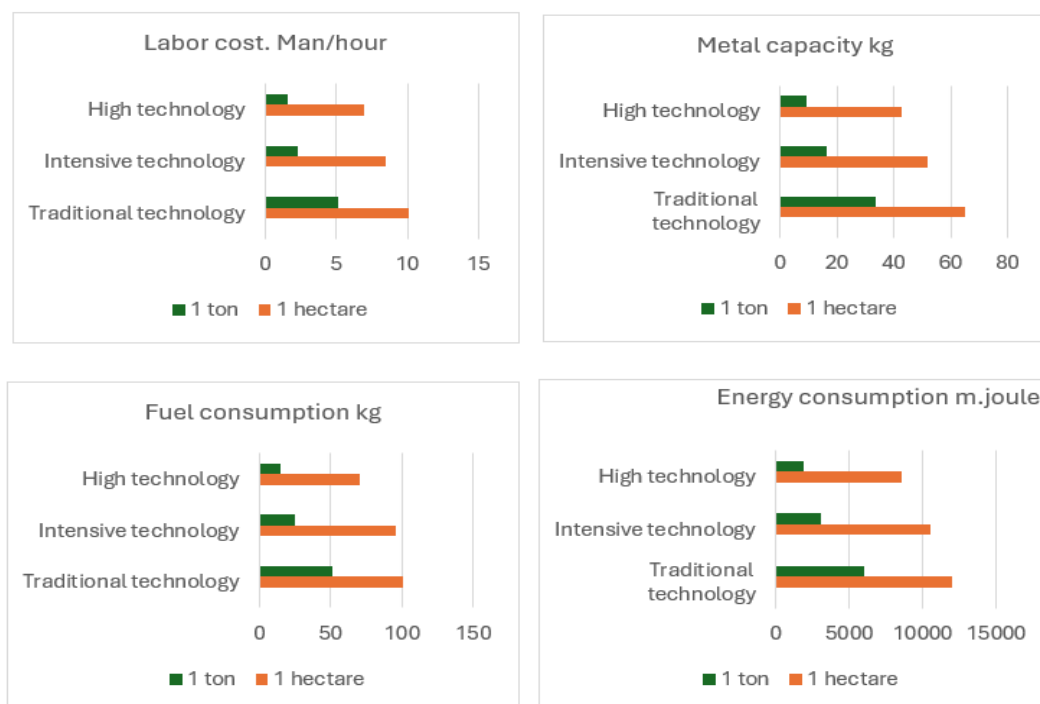


Fig. 2. Diagrams of energy efficiency indicators for the implementation of traditional, intensive and high-tech technological processes.

Conclusions

In the case of the study of red earth soils of Western Georgia, technical and economic indicators were calculated for traditional, intensive and high technologies and indicate that in terms of specific labor, fuel, metal consumption and energy consumption, the high-technology work process proves to be the most effective.

As a result of the analysis of technical and economic indicators of technologies for radical improvement of forage lands, it was determined that the smallest amount of resources per unit of production will be required for the implementation of the high-tech option: labor costs - 6.91 man-hours/hectare, fuel costs - 70.2 kg/hectare, metal consumption - 42.9 kg/hectare, energy consumption 8525.7 M. J/hectare.

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