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SMALL MECHANIZATION - AN ALTERNATIVE FOR INDIVIDUAL MOUNTAIN FARMS

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Abstract. *Regardless of the main concern of the inhabitants of the mountain area, the mechanization of the works from their own household has a special importance in the development and efficiency of the activity by achieving high working capacities, shortening execution times, reducing the necessary physical effort, diminishing the necessary labour force, promoting a modern ecological activity. Only mechanization allows the achievement of superior work capacities with a reduced consumption of labour and physical effort. In this paper are presented some new machines, designed and made for the mechanization of some technological links, in aggregate with low power tractors.*

Keywords: mechanization, grassland, individual mountain farms, management, technological solutions

1. Introduction

In the mountainous area, on the agricultural surfaces, a series of restrictive factors on the production act, such as: the slope and the deficient orography of the land with small and irregular surfaces; climate (due to high altitude); low fertility; skeleton and rock on the surface; surface erosion; deep erosion and landslides; high acidity; invasion with worthless vegetation. Due to the action of these limiting factors, the agricultural yields obtained are lower than those obtained in other more favorable areas of the lowland-plains regions.

From the surface of meadows in our country, approx. 4.9 million hectares, over 2.94 million hectares (60 %) are located in hilly and mountainous areas.

Concerning to conditions in which the farm is located, the mechanization of agricultural works is of particular importance for: high work capacity; reducing the necessary physical effort; decreasing the need for labor per production unit; and increasing the economic efficiency of the farm etc.

Today it is inconceivable that a farmer in the mountain area can live only on the income from his own activity without benefiting from a high degree of farming mechanization. Only mechanization allows for higher work efficiency with reduced labor and physical effort.

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In many cases, even in a high degree of mechanization, the income per unit area differs depending on the topography of the land because:

-production decreases with increasing slope;

-the cost of the works increases proportionally with the increase of the slope (on the one hand due to the work capacity, which decreases with the increase of the slope, and on the other hand due to the higher afferent cost of the machines specific to work on sloping lands).

The influence of the land slope on the mechanization of agricultural works is of high importance for building new machines and equipments destined to be used in grasslands farming.

The slope of the land has a major influence on the possibilities of grassland farming mechanization because over 66.5 % of their surface is located on lands with a slope of over 8 % (4.57 º) [8].

As the number and intensity of agricultural work on hayfields is much higher than on pastures, Table 1 shows the distribution of this area according to the slope of the land. It is observed that 68.9 % of the surface of permanent hayfields is located on slopes greater than 8 % (4.57 º).

Table 1. Distribution of permanent hayfields by slope [8]

No.	*Slope of the land*		*% of total hay area*
	%	º	%
1	< 2	< 1.15	20.1
2	2 ... 5	1.15 ... 2.86	4.7
3	5 ... 8	2.86 ... 4.57	6.3
4	8 ... 12	4.57 ... 6.84	11.7
5	12 ... 18	6.84 ... 10.20	17.7
6	18 ... 25	10.20 ... 14.00	20.8
7	25 ... 50	14.00 ... 26.56	15.0
8	> 50	> 26.56	3.7

The slope of the land influences the farming mechanization due to the additional, disruptive forces it generates. Thus, the slope of the land produces a series of technical and functional problems when working with specific machines on meadows, which have a negative effect on [2, 3, 4, 5]: quality of work; work capacity; safety in operation of the aggregates; the required actuating power; the condition of the vegetal carpet of the meadow; and costs on energy and materials.

Agricultural machinery system represents the totality of machines, machinery and equipment intended for carrying out agricultural works.

Specific machine system: machinery, equipment and machinery necessary for the mechanization of agricultural work in a particular field.

Depending on the type of agricultural work, the machine system specific to the mechanization of meadow farming is divided into the following categories:

a) Equipment and machinery for grassland maintenance works (Figure 1);

b) Equipment and machinery for grassland improvement works:

b1) improvement works by surface methods (Figure 2);

b2) improvement works by radical methods (Figure 3).

Fig. 1. Specific equipment and machinery for grassland maintenance works.

Fig. 2. Specific equipment and machinery for grassland improving by surface methods.

Fig. 3. Specific equipment and machinery for grassland improvement by radical methods.

In this context, the purpose of the paper was to pay attention to the creation of an agricultural machinery system which has to respond to the needs of the farmers, research and development stations, parks and recreational areas situated in the mountain areas of Romania.

This new agricultural machinery system is useful for working the land using small mechanization adapted to small surfaces and various slopes.

2. Materials and Methods

In this research work, new agricultural machinery for small mechanization was designed, realized and tested within Research-Development Institute for Grassland Brașov, Romania.

The machines, machinery and equipments were built in such a way to be suitable for individual farms, experimental fields, parks and recreational areas in the mountain zone etc.

The study presents the following experimental models: the equipment Type EP-4 for hoeing the experimental fields, a Fixed-tooth harrow, type GCF 2.0, a Plow, type PP-1-20, a Sowing machine, type MS 7, and a Sowing machine, type MS 9, regarding their image and technical characteristics.

The concept, design, execution and tests of the experimental models were achieved by the researchers whose expertise is in the field of mechanization.

3. Results and Discussions

3.1. Experimental field hoeing equipment, type EP 4

The equipment for hoeing the experimental fields, type EP 4 (Figure 4), mobilizes the soil between the rows of seed plots (grasses and perennial legumes of grassland) or other crops, performing weed eradication and works necessary for the maintenance technology.

Fig. 4. Work aspects of the experimental model for field hoeing, type EP 4

Table 2. Main technical characteristics of the Experimental field hoeing equipment, type EP 4 [1]

No.	*Characteristics*	*Specifications*
1	Equipment type	carried
2	Energy source	9.5 ... 22 kW (13 ... 30 HP)
3	Operating width	2.4 m
4	Number of operating sections: - L-shaped knives - arrow knives	4 pcs 8 pcs (4 left + 4 right) 4 pcs
5	Overall dimensions: - length: - width: - height:	 1,100 mm 2,620 mm 1,350 mm
6	Equipment weight	120 kg

The EP 4 experimental model is a type of agricultural equipment carried by the three-point linkage mechanism (category I) of the drive tractor. It consists of the following main parts: the assembled frame; four independent sections; active organs; two operating wheels.

The section articulated mounting on the frame, through of the parallelogram mechanism, allows copying the ground unevenness (in vertical-longitudinal plane and in vertical- transversal plane) without changing the angle of attack of the operating organs.

3.2. Fixed-tooth harrow, type GCF 2.0

Fixed-tooth harrow, type GCF 2.0 (Fig. 5), is used to aerate the meadows in early spring, as well as to clean/spread the manure after the end of each grazing cycle.

This is an agricultural machine of the carried type on the three-point linkage mechanism of the drive tractors.

Fig. 5. Aspect of the experimental fixed angle harrow model, type GCF 2.0

The main components of the fixed-tooth harrow are: assembled frame; field of harrows with fixed fangs; harrow support chains.

Table 3 shows the main technical characteristics of the experimental fixed-tooth harrow model, type GCF 2.0.

Table 3. Main technical characteristics of the experimental fixed-tooth harrow model, type GCF 2.0

No.	*Characteristics*		*Specifications*
1	Energy source		Wheel tractors of 9.5...22 kW (13...30 HP);
2	Operating width		2.0 m;
3	Number of toothed harrows		2 pcs;
		• number of teeth / harrow field:	25 pcs;
		• total teeth number:	50 pcs;
		• the distance between two consecutive teeth	40 mm;
4	Overall dimensions		
		- length:	1,250 mm;
		- width:	2,100 mm;
		- height:	1,000 mm;
5	Weight		80 kg

3.3. Plow, type PP-1-20

The plow, type PP-1-20, is used for cultivating the soil in furrows, crushing and overturning them to a certain depth in the arable layer of the soil on arable land, respectively on the crop areas, perennial and grassland fodder plants to be improved by complete restoration (Figure 6).

Fig. 6. Aspect of the experimental carried plow model, type PP-1-20

The plow is an agricultural machine of the carried type on the three-point linkage mechanism of the drive tractor.

The main components of the plow are: assembled frame and a working body consisting of a operating device with a corman.

Table 4 shows the main technical characteristics of the experimental carried plow model, type PP-1-20.

Table 4. Technical characteristics of the experimental carried plow model, type PP-1-20

No.	*Characteristics*		*Specifications*
1.	Energy source		Wheel tractor of 9.5...22 kW (13...30 HP);
2.	Operating width		20 cm;
3.	Operating deep		20 cm;
4.	Overall dimensions		
		- length:	1,100 mm;
		- width:	600 mm;
		- height:	500 mm;
5.	Weight		30 kg

3.4. Sowing machine, type MS 7

The machine (Figure 7) is used for sowing grassland fodder plants on relatively small areas, in experimental fields, in parks, in recreational areas etc.

In addition to sowing, it also performs rolling before sowing.

The experimental sowing machine, MS 7, is a self-propelled agricultural machine. It has a single-cylinder spark-ignition heat engine that develops 2.57 kW (3.5 HP). From this, through the centrifugal clutch, the snail-wheel drive, the PTO shaft and a chain drive, the movement reaches the roller, through which the car is propelled. The seed metering devices are also driven by a chain drive and the agitators by a two-wheel drive.

The main components of the machine are: assembled frame; seed hopper; sowing equipment; the mechanism for transmitting motion to the dosing apparatus and agitators; heat engine; roller; support wheel; horns for handling the machine.

Fig. 7. Sowing machine, type MS 7:

a. Aspect of the experimental model; **b.** Work aspect**.**

Table 5 shows the main technical characteristics of the experimental sowing machine model, type MS 7.

Table 5. Technical characteristics of the experimental sowing machine model, type MS 7 [7]

No.	*Characteristics*		*Specifications*
1.	Operating engine		
		- type	single-cylinder
		- power	2.57 kW (3.5 HP);
2.	Operating width		87.5 cm;
3.	Number of coulters		7 pcs;
4.	Inter-row distance		12.5 cm;
5.	Sowing deep		0.5...4.0 cm;
6.	Type of metering devices		fluted cylinders;
7.	Type of coulters		simple cultural;
8.	Seed box volume		25 l;
9.	Overall dimensions		
		- length:	1,540 mm;
		- width:	1,040 mm;
		- height:	1,090 mm;
10.	Weight		140 kg

3.5. Sowing machine, type MS 9

The machine is intended for sowing grassland fodder plants or other crops on relatively small plots, individual farms, experimental fields, parks, recreational areas etc. (Figure 8).

Fig. 7. Aspect of the experimental sowing machine model, type MS 9

The sowing machine, type MS 9, is agricultural machinery carried on the three-point linkage mechanism of the drive tractors.

The main components of the seed drill are: assembled frame; seed box; sowing equipment; the mechanism for transmitting the motion to the metering apparatus and agitators and ring harrow to cover sown seeds. The power source is an all-wheel drive articulated tractor of 9.5 kW (13 HP).

During the aggregate operating time, the sowing equipment distributes, through the pipes and the cultural coulters, the desired species or seed mixture, and a harrow with metal rings covers with cultivated soil the sown seeds.

The drive of the seed metering devices is done from the wheel of the seed drill, by means of a chain transmission, and of the agitators by means of a cam mechanism.

By using cylindrical fluted seed distributors changing the active length of the grooved distributors, corroborated with the adjustment of the movable bottoms, different sowing rates can be achieved.

Table 6 shows the main technical characteristics of the experimental sowing machine model, type MS 9.

Table 6. Technical characteristics of the experimental sowing machine model, type MS 9 [6]

No.	*Characteristics*		*Specifications*
1.	Energy source		Wheel tractors of 9.5...25.7 kW (13...35 HP);
2.	Operating width		112.5 cm;
3.	Number of coulters		9 pcs
4.	Inter-row distance		12.5/25.0/50.0 cm;
5.	Sowing deep		0.5...4.0 cm
6.	Type of metering devices		fluted cylinders
7.	Type of coulters		simple cultural;
8.	Seed box volume		100 l;
9.	Overall dimensions		
		- length:	950 mm;
		- width:	1,555 mm;
		- height:	850 mm;
10.	Weight		160 kg.

Conclusions

(1) The experimental models presented in the paper are suitable for individual farms in the mountain area.

(2) They have small dimensions and weight, being an advantage both for performing the agricultural works executed in the slope conditions and from the point of view of the environment protection through a lower compaction of the soil.

(3) They perform work indices corresponding to the specific agrotechnical requirements of the farming works.

(4) They require relatively smaller energy sources, which are relatively cheaper and more easily accessible from a financial point of view.

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