EXPERIMENTAL RESEARCHES ON THE TECHNICAL EQUIPMENT FOR HARVESTING MISCANTHUS RHIZOMES

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ABSTRACT

The paper presents experimental research results under laboratory conditions of the technical equipment for harvesting Miscanthus rhizomes in order to establish constructive and functional parameters: lengths, widths, total heights, constructive working depth, clearance, ground gauge, mass values, checking the machinery coupling to the tractor, rotation frequency of separator driving shaft, amplitude and frequency of separator grate movement.

The results obtained confirm fulfilling the requirements regarding to constructive and functional parameters of Miscanthus rhizomes harvesting equipment.

INTRODUCTION

One of the renewable sources assuring the necessary biomass for bioenergy generation, wide spread in EU countries in the last decades, is Miscanthus culture. By capitalization of Miscanthus culture economic advantages can be assured, especially regarding the environment. This can be used for electrical energy producing and/or thermic both in large power plants (30 MW), using tons of biomass every year, and in small households using a few tons, during winter months. By using Miscanthus plant in the burning process, carbon dioxide emissions are reduced and methane ones, released from the deposits, are eliminated [6].

Miscanthus cultivation has a positive impact on soil erosion. One of the significant factors contributing to soil erosion is intensive agriculture. The large number of mechanised works, necessary in the most conventional agricultural works (for food industry), destroy soil structure and texture and accentuate erosion processes due to environmental factors (water, wind). It is to be expected that introducing Miscanthus culture (perennial, reduced number of soil works, high density per hectare, etc.) to lead to a significant reduction of these phenomena, described above.

A number of studies performed in the USA showed that Miscanthus cultures impact on soil erosion processes is minimum (fig. 1).

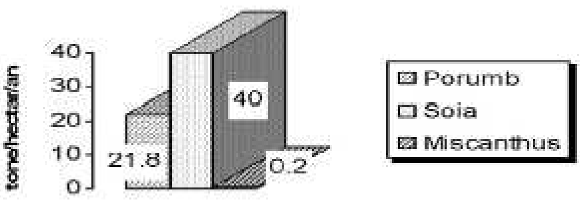

***Fig. 1 - Soil loss associated with cultivation of various types of agricultural crops and Miscanthus* [7]**

Miscanthus plant energetic potential may be explored in three main directions: bio-ethanol obtaining, biogas or solid biomass (chopped matter, pellets, or briquettes), then converted into energy through thermal processing.

A hectare of Miscanthus can produce an average amount of 23 ... 25 tons of biomass with a humidity of 10 ... 16% and a calorific value equivalent to 14 tons of coal and 10 tons of oil. Miscanthus is one of the most efficient cultures. Net calorific value, relative to the dry biomass, is 17 MJ/kg or 4.75 kWh/ kg.

An extremely important role in establishing a new culture is played by the quality of the seedling material. This way, rhizome harvesting is one of the most important operations with major influence on biomass production. [1], [2], [5].

In most cases, for harvesting the seedling material are used other machines destined to harvest other crops such as potatoes and onions by adapting various constructive solutions with less satisfying results in terms of seedling material quality and energy consumption for the harvesting work. In this context, INMA proposes harvesting equipment for Miscanthus rhizomes, specially dedicated to this crop.

MATERIAL AND METHOD

Experiments under laboratory conditions to determine constructive and functional parameters of the technical equipment for harvesting Miscanthus rhizomes were carried out at INMA Bucharest – Testing Department.

An ERR-type equipment was used for harvesting Miscanthus rhizomes (fig. 2) working in aggregate with 70-80 HP tractors.

Fig. 2 - Technical equipment for harvesting Miscanthus rhizomes ERR **[4]**

The technical equipment ERR is an agricultural machinery of carried type, made of the following main subassemblies:
- Frame;
- Eccentric separator.
- Displacement plough;
- Left and right wheel;
- Hydraulic motor.

Measuring equipment and devices used for testing

Measuring and control equipment and devices used to test the technical equipment for harvesting Miscanthus rhizomes, under laboratory conditions, are the following:
- for size: 3m measuring tape, 8m measuring tape, 60m measuring tape;
- for weight: platform balance RW10P (fig. 3), mechanical balance with measuring range from o to 150 kg and balance of 6 kg;

Fig. 3 – Determining weight of tractor aggregate with technical equipment for harvesting Miscanthus rhizomes **[4]**

- for speed: digital tachometer EXTECH (fig. 4) allowing to determine speed based on direct contact with the revolution surface or optically using a reflecting surface. Device using temperature is between 0 and 50^{o}C.

Fig. 4. Electronic tachometer **[4]**

- to determine the amplitude and frequency of movement: displacement transducer and amplification and data acquisition system;

RESULTS AND DISCUSSIONS

To determine constructive and functional parameters the following results were obtained:

- *total length, width, height* – overall dimensions resulted after measurements are presented in Table 1:

Table 1

No.	Characteristic	UM	Value
1.	Length	mm	2090
2.	Width	mm	1590
3.	Height	mm	1395

- *constructive working depth* – the values were determined by measuring the distance between plough top and the support surfaces of the wheels adjusting working depth, the technical equipment being placed on a flat, hard and horizontal surface with an admitted longitudinal and transversal inclining of maximum 0.5%. The tractor used in aggregate with the agricultural machine was a 70...80 HP wheeled tractor equipped with three-point suspension mechanism, category 2 according to SR ISO 730:2012.

Constructive working depth dimensions, resulted after measurements are:
- minimum working depth 0 mm
- maximum working depth 250 mm

- *clearance* – the values were determined by making the measurements using a measuring tape and other helpful tools (ruler, square), the technical equipment being placed on a flat, hard and horizontal surface with an admitted longitudinal and transversal inclining of maximum 0.5%. The clearance value in transport position was of 350 mm.
- *ground gauge* - the values were determined in operating position by measuring the distance between the median plans of the support wheels. The ground gauge was of 1868 mm.
- *mass values* of the technical equipment in aggregate with the tractor TD 80D New Holland were determined by using platform balances RW10P. (Table 2)

Table 2

No.	Characteristic	UM	Value
1.	Total mass of tractor TD 80D New Holland - front, M_{pf} - back, M_{ps} - total, M_{pt}	kg	1516 2274 3790
2.	Mass of tractor TD 80D New Holland with technical equipment ERR - front, M_{Tpf} - back, M_{Tps} - total, M_{Tpt}	kg	1416 2869 4285
3.	ERR equipment mass	kg	495

Percentage value of the load on the front axle reported to the total mass of tractor TD 80D with ERR technical equipment is given by the formula: [3]

$$\frac{M_{Tpf}}{M_{Tpt}} \cdot 100, \ [\%]$$

A value of 33.04% resulted; it satisfies the stability requirement on longitudinal plan so that the aggregate would not rear (according to internal regulations on vehicles movement, the load on the front axle must be higher than 20% of the aggregate mass)

- *equipment coupling to the tractor* – table 3 presents the coupling elements with three-point suspension mechanism of tractor TD 80D New Holland, according to SR ISO 730:2012. [3]

Table 3

No	Characteristic	Symbol	Value
1.	Hole diameter of upper coupling bolt, mm	d_1	$25.7(_0^{+0.2})$
2.	Distance between upper ring inner sides, mm	b_1	min 52
3.	Diameter of coupling bolt to upper coupling bar, mm	D_1	$25.5_{-0.13}$
4.	Diameter of coupling bolt to lower coupling bar, mm	D_2	$28_{-0.2}$
5.	Hole diameter of coupling bolts splint, mm	d	min 12
6.	Distance to the hole for the splint, mm	b_3	min 49
7.	Vertical distance between coupling points, mm	h	610±1.5
8.	Aperture between coupling points, mm	l	825±1.5

▪ *rotation frequency of separator driving shaft* (fig. 5) was determined by using a digital tachometer for engine operating speed of 2200 rev/min. The average value obtained when determining the rotation frequency of separator driving shaft was of 343 rev/min.

Fig. 5. Determining rotation frequency of separator driving shaft

▪ *amplitude and frequency of separator grate movement* – were determined using an amplification and acquisition system that took over data from a displacement transducer WA50; then, the system processed and saved data on a computer as graphs (fig. 6).

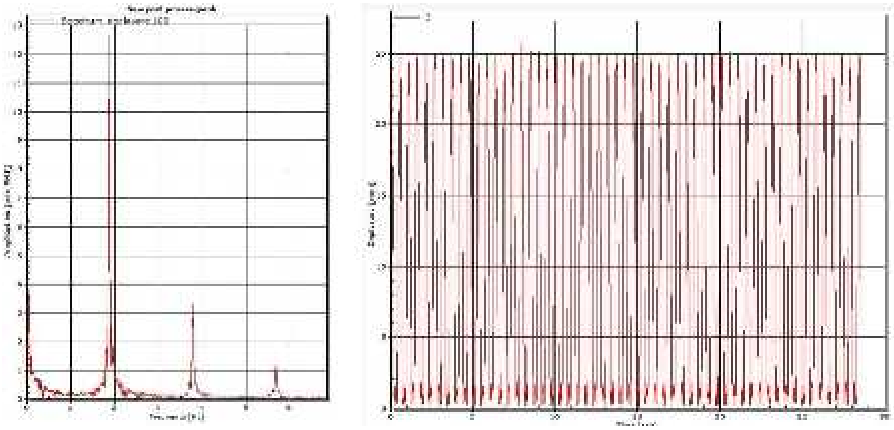

Fig. 6. Amplitude and frequency of oscillating separator grate movement

Data analysis shows movement frequency of 5.7 Hz and 25 mm displacement of oscillating grate tip.

CONCLUSIONS

Miscanthus is one of the most efficient cultures in terms of input amounts necessary to obtain the crop, having net calorific value, relative to the dry biomass, of 17 MJ/kg

An extremely important role in establishing the Miscanthus culture is played by the quality of the seedling material. Rhizome harvesting is one of the most important operations with major influence on biomass production.

The equipment for harvesting Miscanthus rhizomes subjected to experimental researches has been designed to meet the coupling requirements (according to SR ISO

730:2012) with a rotation frequency of separator driving shaft of 343 rev/min, a grate separator movement frequency of 5.7 Hz and 25 mm displacement of oscillating grate tip, allowing a good functioning and making possible to separate Miscanthus rhizomes.

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