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THE COSTS OF SWEET SORGHUM *(SORGHUM VULGARE SACCHARATUM)* PRODUCTION, ACCORDING TO THE LEVEL OF THE FARM'S MECHANIZATION

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Summary: Our work is a comprehensive examination that analyses the machine fleet formation and machine use of plant production farms that grow sweet sorghum too by using computer aided modeling. It considers the characteristics of machines used at the production technologies of different plants and it especially focuses on the appliance of machines with the convenient capacity and level from the side of costs at different farm sizes.

The total production cost of sweet sorghum per hectare in case of small-scale farm size is minimum 715 EUR. Examining the large-scale production the costs reduce, but they can not be reduced under the 610 EUR/hectare level.

Key words: sweet sorghum, plant production, farm mechanization, farms

1. INTRODUCTION

The goal of the research is the technical-economical analysis of the production-technology system of the sweet sorghum that is known as energy plant and nowadays as a promising base material of biotechnological industries.

Work done *by an efficiently developed machine system* is a significant condition of the fruitfulness of farming. The machine prices and the cost of their utilization are extremely high and all these result in extraordinarily high production costs. *Rational machine utilization* is a definitive factor of the efficiency of venture-farming.

We have accomplished the examinations by taking power-machines from different quality and cost levels as base. Through this we have showed that not only the size of the farms affects the amount of the operational costs, but the standard of mechanization too.

2. METHOD

2.1. The sweet sorghum *(Sorghum vulgare saccharatum)*

The sweet sorghum is one of Hungary's plants that is capable to produce the greatest amount of biomass and it's production can be fitted in the conventional alternation of the cereals and industrial plants and the outstanding yields can be ensured at lower costs than other cultures. From the point of view of energetic use, the component of the sweet sorghum that is classed as secondary product, the high sugar content solution that can be pressed from the spears, that is a suitable base material for bioconversion methods. The amount of the productable sugar reaches or exceeds the amount of the glucose that can be produced from cereals grown on a land with the same size. The complex use of the components that can be obtained from the sweet sorghum can significantly increase the reachable profitableness of agriculture.

The plant is subtropical, needs hot weather and takes drought significantly. It is also called durra or sweet-cane. It was grown in a higher amount between the two world wars. After the World War II, until the start of the sugar production, the sugar containing syrup pressed and condensed from the plant was used instead of sugar. Nowadays it is mainly used to produce silage fodder, planted with silage corn The growing conditions are very advantageous, because the sweet sorghum gives a stable yield even in case of poor water supply (60-70 tons/hectare) (Kocsis 2009). [5]

2.2. The surveyed crops

The surveys can be conducted by *modeling* the machine working processes of agricultural production. On the base of field crop production a crop plan including cereal plants for human consumption, *sweet sorghum* for animal breeding and for *energy* production purposes and oil seeds – as sunflower and the nowadays very popular crucifer - appropriate for human consumption and energy production as well and reflecting the special features of production in Hungary has been applied. Depending on venture size the proportion of the crop area of the individual plants has been stipulated in view of the agronomical and production technological conditions.

2.3. The significance of machine utilization, the machine families applied, the parameters of model calculations

In the utilization costs of the more and more up-to-date and expensive power machines the proportion of *fixed costs*, especially amortization and maintenance is very high. This expense can be decreased by increasing *utilization*. If the applied means are coupled to the individual field work operations at their effective operation cost – i.e. taking the rate of utilization into account – the effect of *working-hour performance* on costs will become measurable.

Basically the cheapest power machine families used in Hungary on the one hand and the ones with the highest possible investment cost demand available on the market of agricultural machinery on the other have been the subject of the survey (Magó 2008). [6]

The basic figures of machine utilization have been determined with the help of the data base of the Hungarian Institute of Agricultural Engineering of Ministry of Rural Development. [3]

The *model-calculations* have affected the farm size points of machine stock development in a farm size of 30 and 1000 ha. On this basis we can come to statements affecting a wider segment of the agricultural property structure, resp. to conclusions concerning mechanization and machine utilization.

3. RESULTS

3.1. The constitution of the machine system in case of the examined operating sizes

The power-machine system that can be ordered to serve the examined operating size of 30 hectares to finish the soil preparation in a good quality consists of the minimal 40 kW output piece and the attachable soil tilling, nutritive spreading and insecticide process machines. In case of the 1000 hectare farm size that is the base of the large-scale examination, the minimum is the tractors with 60-120 kW of output that can be the base of the machine works. The different output-categories are represented by two power-machines in each case. The easier nutritive supply and insecticide tasks are done by the machines with smaller output and the heavier tasks are done by the machines with higher output. The *materials handling to the depot* can also be done by these tractors by using tow-cars to increase the exploitation of the machines.

In case of farm size of 30 hectares, the finishing of the harvesting works as wage-work is the most efficient. According to the calculations, on a 1000 hectare sized farm, to reach the acceptable capacity-utilization, one *cereal combine-harvester machine* can be operated as the property of the farm. The appliance of the self-propelled silo harvester that does the gathering of the sorghum as a property, highly increases the machine costs of the farm, therefore it can be seen in the chapter *results* in details that it is more advantage out to use a self-propelled silo harvester for commission work.

3.2. The number of the executed working-hours in function of the power-machine category, the mechanical level and the farm size

The number of the executable working-hours of the power-machines in case of different farm sizes determines the composition to each category of the power-machine system;

In case of the examined *smaller sized farm* (30 hectares) based on our calculations *low exploitage* can be reached to the tractors: maximum 435 working-hours/year.

In case of large estate sizes (1000 hectares) the executed machine working-hours of the farms power-machine fleet, based on our model calculations is 6650 working-hours, from which the tractors represent a major (1100 working-hours/year (power-machine

with 60 kW output) and 1700 working-hours/year (power-machine with 120 kW output)) part.

With a clever-chosen cereal harvesting machine at *one thousand hectare* farm size executing about 450-500 working-hours it reaches *significant* exploitage, that results in *acceptable* operational cost. The annual capacity exploitage of the self-propelled silo combine in case of own property is only 150 working-hours, that makes the idea of purchasing the machine as property to think it over.

The number of the working-hours at *unity area* will *decrease* by the increasing of the estate size. *In case of 30 hectare* farm *size*s *14,4 working-hours/hectare/year* materializes. In case of the 1000 hectare farm size about *6,6 working-hours/hectare /year* can be measured annually.

These values characterize the power-machine usage with low investment costs and slightly change in case of using power-machine ranges with high investment costs. The modern power-machine implement connections finish their work in a shorter time, that can also be seen in the mentioned specifically indicator too. Annually, depending on the estate size, the use of machines with higher price and technical level mean 0,2 - 0,6 working-hours per hectare preference. However, assuming only inner, private working, this preference is disadvantageous, because the annual working-hour execution of the different machines decrease, that increases their specifically usage costs.

In case of a **30 hectare sized farm** the machine work demand of sweet sorghum that's production is fitted in the rotation of crops is 120 working-hours, that is 14,8 working-hours/hectare. This value is slightly higher than the economic average. In case of a **1000 hectare sized farm** the machine work demand of sweet sorghum that's production is fitted in the rotation of crops is 1675 working-hours, that is 6,7 working-hours/hectare. This marks well that the production of sweet sorghum is a labour-intensive activity, because this value is also higher than the value that is specific to the whole farm. By using *modern machines* the shown working-hour execution parameters will decrease with 4-5 %.

With the increasing of the farm size, the specific number of the needed machine working-hours for a unity of area decreases and the values almost half in case of using high output machines at large-scale production.

In case of small-scale production the significant number of shift-hours increases the living work outlay, thereby *increases the employment*. In the farms with this size the use of small output machines is reasonable. However the proper usage of the small capacity machines is not ensured either, so the significant constant costs induce *higher operational costs.*

3.3. The analysis of the machine usage and machine investment costs

Applying *low-level* power-machine fleet, the annual machine use cost of a **30 hectare** farm that produces sweet sorghum too is 11.785 EUR, that is 393 EUR per hectare. The specific machine cost of the produced crops is the following: wheat 365 EUR/hectare, sunflower 375 EUR/hectare, rape 395 EUR/hectare, sweet sorghum 440 EUR/hectare. In the sowing plan the ratio of the plants is the following: wheat 40%, sunflower 25%, sweet sorghum 25%, rape 10%.

The whole machine investment cost in case of a **30 hectare** plant production farm is 37.145 EUR, that is 1235 EUR per hectare. The whole investment cost of the machines applied in the production of the sweet sorghum is 23.570 EUR, that is 2975 EUR per hectare.

Applying *modern power-machines* the annual machine use cost is 14.645 EUR, that is 491 EUR per hectare. In case of the produced plants the machine costs are the following: wheat 460 EUR/hectare, sunflower 475 EUR/hectare, rape 500 EUR/hectare, sweet sorghum 540 EUR/hectare.

In this case the whole cost of machine investment is 63.930 EUR, that is 2130 EUR per hectare. The whole investment cost of the machines applied in the production of the sweet sorghum is 47.860 EUR, that is 5965 EUR per hectare.

Those who work on **small sized** farm can count with low power-machine utilization, that also has effects on the use costs per working-hour of the tractors. This value is 19 EUR/working-hours in case of the 40 kW tractors that are usually used in small works. At this production size, the calculated cost of the borrowed used cereal harvester and self-propelled silo combine is 52,5 EUR/working-hours and 72,7 EUR/working-hours. In case of *modern machines* the specific cost of the mentioned tractor to a time unit is 24 EUR. The cost of the cereal combine is 73,6 EUR/working-hours. In case of an ensilage cutter, we can also count with the given values, because in the database that we used for the calculations we haven't found two different technical levels from the harvesting machines with these functions.

Considering a **1000 hectare sized farm** in case of *low level* mechanization, taking the above mentioned sowing plan ratios the annual use cost of the machines is 303,5 thousand EUR, that is 303,5 EUR/hectare. The machine cultivation cost per hectare to each of the plants:

wheat: 240 EUR, sunflower 270 EUR, rape 245 EUR, sweet sorghum 465 EUR.

Basically the machine investment costs are 814,3 thousand EUR, that is 814,3 EUR calculated for area unit. For the mechanization of the sweet sorghum production itself, 623,2 thousand EUR is needed, that means specifically 2500 EUR/hectare.

If the use of the self-propelled ensilage cutter machine is not as an own property, than it is *leased work*, the machine use cost of the whole farm is 267,8 thousand EUR. The specific value for a hectare is 267,8 EUR. And the specific machine cost of the sweet sorghum production is the advantageous level of *320 EUR/hectare*.

The machine investment costs also decrease to 596,4 thousand EUR (596,4 EUR/hectare). In this case the price of the machines that are in close connection with the production of sweet sorghum is 428,6 thousand EUR (1718 EUR/hectare).

With the appliance of *high level* power-machines the annual machine use cost projected to the whole farm is 339 thousand EUR, specifically 339 EUR/hectare. In case of wheat it is 275 EUR/hectare, sunflower 305 EUR/hectare, rape 275 EUR/hectare and sweet sorghum 505 EUR.

It can be observed that the machine cost of sweet sorghum is the highest in every case, compared to the other plant cultures. This is mostly because great volume of the harvesting and crop transporting tasks: at least 60-80 t/hectare of crop has to be harvested and transported to the processing plant.

The machine investment costs are the following: The costs to the whole farm is 1050 thousand EUR, that is 1050 EUR/hectare. The purchasing of the machines that are

needed for the sweet sorghum production cost 810 thousand EUR. The projection of this to one hectare is 3245 EUR.

If the ensilage cutter machine does it's tasks as **leased work**, the costs decrease. As a result of the calculations, the total machine use cost of the whole farm is 303,5 thousand EUR. Specifically it is 303,5 EUR/hectare. The machine work cost of the sweet sorghum production is **365 EUR/hectare**.

The machine investment costs decrease to 832 thousand EUR (832 EUR/hectare) in this case too. With this, the purchasing price of the machines that are part of the sweet sorghum production is 615 thousand EUR (2465 EUR/hectare).

The Figure 1. also shows the previously introduced things, where the upper and lower limit of the machine use costs are shown in function of the farm size, that are determined considering the use of low level power-machines and implements and the expensive power-machines that represent the modern machine technologies.
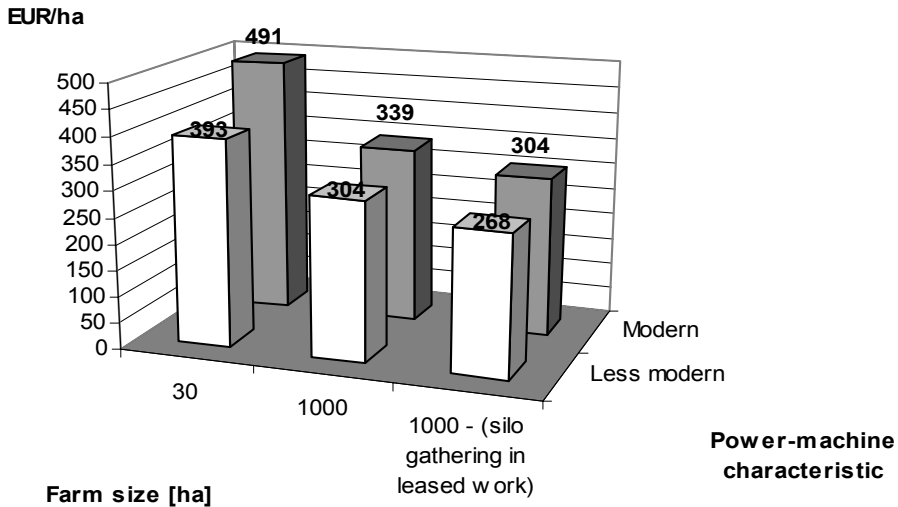

Fig. 1. The specific machine use costs in case of different mechanization levels at farms with the investigated sizes

In large-scale production the exploitage of the power-machines is more advantageous. The tractor with 60 kW output works 1100 working-hours and the medium sized universal power-machine with 120 kW output works 1750 working-hours annually. The use cost of them to one working-hour is 15,7 EUR, and 27,3 EUR. According to our calculations the use cost of the cereal harvester and self-propelled silo combine as own property is 83 EUR/working-hour, and 243,2 EUR/working-hour. If we borrow the ensilage cutter for work, the cost reduces significantly to 97,4 EUR/working-hour. In case of **modern power-machines** the specific cost of the mentioned tractors to a time unit are 19,7 EUR and 31,4 EUR. The cost of the cereal combine is 93,4

EUR/working-hours. In case of an ensilage cutter as we have mentioned, we can calculate with the above given values.

Tab 1. The direct machine operation costs of the work processes of the sweet sorghum production

	In case of using low cost power-machine		In case of applying modern power-machines	
Farm size	30 ha	1000 ha	30 ha	1000 ha
Dimensional unit	EUR/ha	EUR /ha	EUR /ha	EUR /ha
Stubble ploughing	23	15,4	28,6	17,6
Fertilizer distribution	11,8	8	14,8	8,3
Muck-spreading		34,9		39,8
Stubble care	23	15,4	28,6	17,6
Deep ploughing	69,4	33,8	78,9	37,5
Plough levelling	23	15,4	28,6	17,6
Herbicide spraying	10,9	7	13,4	7,8
Chemical pouring	15,5	10,6	19,2	12,1
Preparation of seedbed	15,5	10,6	19,2	12,1
Sowing	22,3	18	25,9	19,8
Chemical plant protection	10,9	7,0	13,4	7,8
Within-the-row cultivation	19,6	7,7	23,8	9
Harvesting	*(65,2)*	171 *(64,1)*	*(65,2)*	171 *(64,1)*
Crop transportation to depot	*(57,1)*	32,9	*(65,3)*	38,5

The operational costs of the work processes of the sweet sorghum production calculated after the computer modeling can be seen on Table 1.

The marked costs in the chart show the direct costs of the machine operation, plus the accessory costs (farm level costs) that increase the discussed values with almost 20%.

The difference between the costs of the small and the large-scale farm size is well-marked. This all can be explained with the efficiency of the machine exploitage. In the field of costs there is also a difference between the use of modern and less modern machines. In case of small-scale farm size, with using less modern power-machines a more advantageous cost level can be reached, although the quality of the work and the circumstances of the working must be considered. In case of large-scale farm size the difference between the operational costs of the less modern and modern machines decrease significantly, because the operation of the less modern machines is more expensive at larger strain and the high level constant costs of the modern machines significantly decrease, according to their better exploitage, considering one unit of work. The values in brackets show the first-cost of the leased work.

The introduced operational costs can slightly modificated with the spatial distribution, because for example in a more undeveloped region the lower wages have decreasing effects on the operational costs, compared to the regions where the wages are higher and the job market is more efficient. Furthermore the feature of the ground, the soil and other factors can slightly have influence on the costs.

It can be established that apart from the level of mechanization, the person who works even on a 30 hectare sized farm using own property machines must face higher specific investment cost than the lower cost level that can be experienced at a 1000

hectare sized farm. If some production technological compulsion forces to do so, the owner should try to increase the exploitage of the machines by offering leased work to others in order to keep the costs at an acceptable level. With this the specific machine use costs can be reduced.

4. CONCLUSIONS

Besides the introduced machine costs we must count with the prices of the input materials of the sweet sorghum production to know the whole cost of the production of the plant. For the nutrient supply we can count with about 150 EUR per hectare. The cost of the seeds is around 40-55 EUR/hectare, the cost of the pesticide reaches 60 EUR to each area unit. Adding all these, we face a minimal input material cost is 250 EUR/hectare. Beside this we must not forget about the cost of the insurance and other supplemental expenses that is connected to the production.

Adding everything, the total production cost of the studied plant per hectare in case of small-scale farm size is minimum 715 EUR. Examining the large-scale industrial production the costs reduce, but they can not be reduced under the 610 EUR/hectare level.

The aim of our research work and the exposition of its results is the professional support of the machine investment decisions and the machine utilization practice of the different size ventures promoting hereby the creation of the conditions of fruitful farming and rational machine investment decisions.

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TROŠKOVI MEHANIZACIJE PROIZVODNJA ŠEĆERNOG SIRKA *(SORGHUM VULGARE VAR. SACCHARATUM)* SA OBZIROM NA MEHANIZOVANOST GAZDINSTVA

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Sadržaj: Određivanje najefikasnijeg sastava mehanizacije za svaku farmu i za svaku vrstu biljne proizvodnje je vrlo značajno u današnje vreme. Struktura i iskorišćenost mašina, koje se primenjuju na posedima različite veličine, utiče na ekonomske informacije vezane uz mehanizaciju proizvodnje.

Uzimajući u obzir sadašnju fragmentiranu strukturu gazdinstva, postavljen je istraživački cilj, da se odredi najefikasnija kombinacija mašina, koja bi se koristila pored proizvodnja žitarica i uljanih biljaka i kod gajenja šećernog sirka na različitim veličinama farmi.

Modeliranje je izvršen sa mašinama sa najnižim i najvišim troškovima da bi se odredio interval mogućih troškova po različitim veličinama poseda. Veličina gazdinstva je varirana između trideset i hiljadu hektara.

Ključne reči*: sirak, biljna proizvodnja, mehanizacija, farma*