DETERMINATION OF THE COST OF MECHANISATION OF FIELD VEGETABLE PRODUCTION TECHNOLOGIES

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Abstract

The economic investigation of field vegetable production is introduced by using the production technology of the most important vegetables, sweet corn, green peas, onion, tomato, carrot and cucumber as examples. The paper aims to promote the popularization of the modern technology of field vegetable production by reviewing production technology and providing useful pieces of information on the operational and economic figures of the machines necessary for production.

The investigations prove that the machine operation costs of field vegetable production are higher than the cost of cereals and oil seeds production. In addition to that the annual utilization level of special harvesters is very low and there are few opportunities to increase it. It is because of the fact that vegetables are produced on smaller territory of land and there is low demand for machine work rent.

Keywords

mechanisation, field vegetable production technology, machine investments and usage costs

1. Introduction

Onion is a very important vegetable that plays a very significant role in human nutrition. Practically onion is produced in every part of Hungary on large, as well as on medium and small farms, on 5-8 thousand hectares altogether. Seed-grown vegetable onion is gradually gaining ground on the traditional onion set production method. In our present days there are good seed-grown species available for farmers. These species can provide good quality products and can be stored well. In addition to that lands can be irrigated well and there are good herbicides available, therefore this production method can be applied safely. Tomato is one of the most popular vegetables in the world, produced on very large lands. Canning tomato is a very significant vegetable in Hungary as well, traditionally produced on a very large land, 3-4 thousand hectares, by transplanting or direct seeding methods.

The total growing area of root vegetables in Hungary is ca. 3-4 thousand hectares including 2-2,5 thousand hectares of carrot growing area. Carrot is a very important vegetable for fresh consumption as well as for the deepfreezing and for the canning industry. The carotin content (α and β 5-30 mg/100mg) of the carrot is the highest among all root vegetables and its sugar (4-6%), ascorbic acid and potassium contents are also remarkable what makes carrot play a major role in nutrition in general, but first of all in infant nutrition. In Europe the total root vegetables production is about 4,5 Million tons on ca. 150 thousand hectares.

Due to the many different ways of its use, different methods are applied in root vegetable production. Early spring vegetables are offered in bundles, later on washed, defoliated ones are offered for fresh consumption. The late varieties are produced either for prompt procession for the canning industry or for long term storage. In accordance with the growing methods there is a wide selection of varieties and different production technologies are applied (Dimény-Fenyvesi-Hajdú 2004).

The cucumber is one our most important vegetable crops, not only the home consumption but the exported quantity is also remarkable. In view of the production area and the quantity produced pickling cucumber is the most significant in Hungary the production area of which is roughly 3-6 thousand hectares. The annual demand of the canning industry for 6-9 cm and 9-12 cm calibrated cucumber is generally 50-60.000 tons. Though the picking of smaller size-fractions (under 6 cm) reduces the quantity of crop the revenues can be increased notably due to the higher price of this fraction.

The most important link in the chain of production and distribution is the solid inland processing industrial background which is inevitable for the export of fresh produce as well (Fenyvesi 2005), (Takácsné György K. 2006).

2. Method

Apparently, the machine working time necessary for the cultivation of the 20 or 100 hectare growing area in case of connected machines has been stipulated related to the individual operations. On this basis the direct operational cost of the connected machines can easily be calculated by multiplying the direct operational cost of the machine per hour with the effective working time. Furthermore, the additional cost of connected machines has also been stipulated which is affected by the capital return on fixed and current assets as well as by the general costs of farming. As a result the cost of the individual operations related to 20 or 100 hectare growing area has been defined the total of which equals the total production costs onion and canning tomato production for 100 hectares and root vegetables & cucumber production on 20 hectares and also the specific cost per hectare has been stipulated.

3. Results

Economic investigations of onion and tomato production on 100 hectares

The results show that the operation costs of working machines for onion production are less than half (25.764 EUR) of that of tractors (47.903 EUR), while the total machine operation cost is 73.667 EUR. Its value per hectare is 736 EUR (Magó-Jakovác 2005a).

It is important to state that the transport of onion during the harvest required a low capacity, only 600 operating hours. It is because of the fact that in this case the crop was transported to the storage of the farm and not to the plant of the processing company which can be even 100 km away from the place of harvest. In that case road transport would be required which is much more costly.

However the machine operation costs of crop transport add up to 30 percent of the total machine operation costs of onion production. It is followed by picking-up (13 percent) and the proportion of other operations to total costs is less than 10 percent, and does not exceed 1 percent in some cases.

The investment costs of machines used in this onion production technology are 601.949 EUR, of which 382.686 EUR is the cost of working machines (64 percent of the total) and 219.263 EUR is the costs of tractors (36 percent of the total). Soil cultivation tasks require a tractor with a power of 140 kW while nutrient supply, plant protection, sowing and harvest require two tractors with a power of 65-70 kW. That results in relatively low investment costs and high tractor efficiency. The total time of machine operation of onion production on 100 hectares is 2.064, of which the tractor with the higher power has a significant part during soil cultivation and harvest, but the operation time of the two smaller tractors is also significant during plant protection and harvest.

The distribution of the costs of operations is very similar to that of machine operation. Harvest has the highest part of the costs (57 percent of the total), followed by soil cultivation tasks (19 percent), then plant protection tasks (10 percent) and then nutrient supply, sowing, and irrigation (3-4 percent).

The technology of canning tomato production is different from the onion technology in the use of the self-propelled harvester. Another difference is that the crop after the harvest is directly transported to the processing company on road which means extra work and additional costs.

The operation costs of working machines used in this tomato production technology is 19.876 EUR (15 percent of total machine operation costs) and the operation costs of tractors are 125.772 EUR (85 percent). The total machine operation cost is 145.648 EUR, while its value per hectare is 1456 EUR (Magó et al. 2005b).

The capacity need of transport during tomato harvest is very high, 2500 operating hours, since in this case crop was directly transported with vehicles of 15 tons of capacity to the processing company which was 80 km away from the place of harvest. Our calculations show that the crop of one hectare requires four turns from transport vehicles. The time of one turn is about 6 hours which means that 4 turns require about 25 hours.

Not surprisingly, 43 percent of the total costs are related to crop transport. It is followed by harvest (25 percent) and the proportion of other operations of the technology is under 4 percent, even under 1 percent in some cases.

The total investment cost of machines in this canning tomato production technology is 694.024 EUR of which the cost of working machines is 297.996 EUR (43 percent) and the cost of tractors is 396.027 EUR (57 percent). In this case the investment cost of the self-propelled harvester significantly increases the costs of machines. Despite the fact that machines with low investment and operation costs were applied in this technology for transport tasks, transport costs still remained high. Canning tomato production on 100 hectares require 4.698 hours of machine operation of which the transport vehicle works for 2500 hours. The tractor of higher power does not have too many tasks except soil cultivation which means that its operation time is not very high. However tractors of lower power are operated for a much longer period during plant protection and harvest tasks. The operation of the self-propelled harvester is also very significant (500 operating hours). Moreover extra tractor capacity is also required during harvest because it has to draw a trailer synchronised with the harvester to collect the crop because naturally the road transport vehicle is not appropriate for moving slowly beside the harvester.

Harvest is the most costs-demanding of all the operations (75 percent of the total operation cost), followed by soil cultivation (10 percent), plant protection (7 percent), and nutrient supply sowing and irrigation (1-2 percent).

Economic survey of root vegetable production on a 20 hectare

It can be stated on the basis of the results that in case of root vegetables production for canning purposes the operational cost of the power machines (6631 EUR) is less than the half of that of the working machines (14.979 EUR). The total operational cost amounts to 21.610 EUR, 1080 EUR per hectare. In case the goods are meant for the fresh market the above indexes are as follows: the operational cost of the working machines (16.790 EUR) is nearby equal to the operational cost of the power machines (17.812 EUR). The total operational cost is 34.602 EUR, 1730 EUR per hectare (Magó et al. 2006a).

It can be stated that the drag picking method harvesting for fresh consumption causes an extra cost of about 500 EUR per hectare plus the 200 EUR/hectare cost of grading.

In view of the operational cost relations it can be stated that in case the final product is meant for industrial use the cost of road transport is about 35%, and the delivery from the field to the depot by tractor about 10% of the total cost. It is followed by the harvesting operation with 19%. Considering the cost of the other operations of the technology the significant ones are the plant protection with 11%, the ridge bed preparation with 7,5%, the deep ploughing and the renewal of ridge beds with 3% each, while the cost proportion of the remaining operations is often less than 1%. In case the final product is meant for the fresh market this order is different. The major cost factor is harvesting with 40%, road transport and delivery by tractor follows with 22% resp. 5%, the proportion of grading is about 11,5%, and in this case the cost of plant protection is 7%, of ridge bed preparation 5%, of deep ploughing 2,5% and of the renewal of ridge beds 2% of the total cost.

The investment cost of the machines applied in the production technology amounts to 602 thousand EUR (554 thousand EUR), out of which the purchasing price of the working machines amounts to 288 thousand EUR, which equals about 48% of the total investment cost (292 thousand EUR – 53%), while the purchasing price of the power machines is 314 thousand EUR, about 52% of the total cost of machines (262 thousand EUR – 47%). In case of power machines it can be stated that one power machine with an engine capacity of 140 kW is needed for the hard cultivation works, while the tasks of nutrients delivery, plant protection and crop cultivation, sowing, harvesting tractor delivery are fulfilled by 70 kW main and a 60 kW aid machine (Ponjičan et al. 2008). For moving the goods in the depot a telescopic loader is also required, first of all in case of root vegetables meant for industrial use. For the road transport of the crop a low-cost trailer can be used. With the above method of applying power machines lower acquisition costs and a more effective utilization of power machines can be achieved.

Root vegetables production on 20 ha demands 726 shift hours of machine work, out of which the two lower capacity tractors represent a great proportion due to delivery of nutrients, sowing, ridge bed renewal, crop protection and harvesting and transport by tractor and the shift hour performance of the high capacity power machine in the course of cultivation is also significant. Road transport with its 300 shift hour capacity demand is the most time-demanding operation.

In case of production meant for fresh consumption the 70kW tractor works even more shift hours due to the time-demanding harvesting. Furthermore, the grading of the crop produced on 20 has demands about 700 shift hours of machine work according to our calculation. In this case the total number of the shift hours performed in the course of the technology is 1526.

Economic survey of cucumber production on a 20 hectare area

The operational cost in case of cucumber production of the working machines (11.196 EUR) is the half of that of the power machines (22.567 EUR). The total operational cost amounts to 33.763 EUR, 1688 EUR per hectare. Taking the manipulation costs amounting to 2238 EUR into consideration the total cost of machine utilization is 36.001 EUR, 1800 EUR per hectare (Magó-Jakovác 2006b).

In view of the operational cost relations it can be stated that the cost of planting is about 16%, and the cost of foil tunnel preparation about 12% of the total cost. The cost of harvesting is also 12%. The delivery by tractor for pre-grading and the

consecutive road transport to the processing factory represents a proportion of 7 resp. 10%. Considering the cost of the other operations of the technology the significant ones are the plant protection with 10%, the ridge bed preparation, the mulching – hauling the hosepipe and irrigation with 6% each while the cost proportion of the remaining operations is often round 1-2%. The cost of grading does not exceed 5% of the total cost.

The investment cost of the machines applied in the production technology amounts to 593.996 EUR out of which the purchasing price of the working machines amounts to 197.300 EUR, which equals about 33% of the total investment cost while the purchasing price of the power machines is 313.096 EUR, about 53% of the total cost of machines. The purchase price of manipulating machines is 83.600 EUR, about 14% of the total investment.

In case of power machines it can be stated that one power machine with an engine capacity of 140 kW is needed for the hard cultivation works, while the tasks of nutrients delivery, ridge-bed preparation, mulching, hauling the hosepipe, planting, foil tunnel preparation, plant protection, harvesting and tractor delivery are fulfilled by a 70 kW main and a 60 kW aid machine. For the road transport of the produce a low-cost trailer can be used. With the above method of applying power machines lower acquisition costs and a more effective utilization of power machines can be achieved.

Cucumber production on 20 ha demands 1080 shift hours of machine work, out of which the two lower capacity tractors represent a great proportion, about 800. In comparison to this the 44 shift hour performance of the high capacity power machine in the course of cultivation is negligible. Road transport with its 150 shift hour capacity demand is one of the most time-demanding operations.

The time demand of manipulation is over 500 shift hours, in which the working hours of the smaller capacity machine type UBV are dominant.

The figures of the present survey are calculated on the basis of high quality and valuable power machines which ensure effective performance. Consequently the acquisition and operational costs of the power machines are also substantial. The prescribed operations can naturally be realized by using power machines of a lower technical level under strict control and in this case the operational cost of the machines can be less than that figuring in the survey (Husti 2002).

Conclusion

It is favourable for onion production that harvest is implemented with tractor-drawn machines without using expensive self-propelled harvesters.

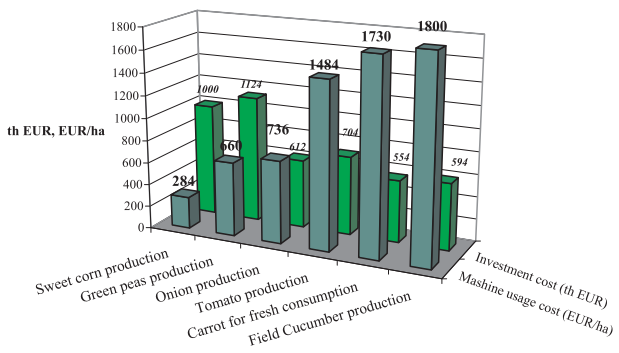

Figure 1. The production costs and investment of the examined field vegetables

The investigations show that the self-propelled tomato harvester completely utilizes its annual operating hour by harvesting 100 hectares of land, which means that its utilization and specific cost is favourable but very cost-demanding because of the high investment cost.

The surveys have proved that the machine work costs of field root vegetable production are higher than the production cost of above mentioned vegetables. (Figure 1) Taking into consideration the extra work connected to grading and consumer packing substantial additional costs arise which can lead to specific costs per hectare exceeding 1700 EUR. In case of a 60 t/ha yield it can easily be calculated that operational costs of machines themselves exceed 3 EURO Cent/kg, and we have to take into consideration the costs of seeds, fertilizers, pesticides, labour and irrigation water.

Also the surveys conducted have proved that the machine work costs of field foil covered cucumber production compared to the production costs of other field vegetable varieties are most higher. The significant hand labour demand is characteristic of this product by planting as well as by the preparation of the foil tunnel but first of all by harvesting when the expert and quality work of 28 persons might as well be needed. But it comes at a price. The picking personnel of 16-28 persons represents a remarkable loan cost but knowing the domestic wage levels this cost is not so very remarkable and the competitiveness of production can be ensured. The present study focuses on the costs of machine operations only the production cost is, therefore, 15 Euro Cent/kg besides a calculated average yield of about 12 t/ha. The cost of hand labour applied during production and the costs of material and other inputs necessary for production were not defined. All these demand further substantial expenditure adding further to the production cost and the cost of the final product.

These figures are characteristic of large-scale production costs and they grow further in case of smaller production units with less effective automation. Considering machine costs it is advantageous if, as in the studied cases, harvesting is done by tractor-pulled working machines instead of expensive self-propelling harvesting machines with high operational costs, as the acquisition cost of connected working machines is more favourable and a better utilization and lower specific operational costs of power machines can be achieved by the use of tractors.

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