техническому обслуживанию и ремонту энергонасыщенных тракторов «Беларус».

Послегарантийное обслуживание осуществляется на основе договора, заключаемого между дилером и конечным потребителем.

В ближайшее время стоит задача совместно с РО «Белагросервис» оснастить дилерские центры современным диагностическим и технологическим оборудованием.

MINIMIZATION OF GRAIN HARVEST COSTS THROUGH THE SELECTION OF OPTIMAL STRATEGY OF EQUIPPING OF FARMS WITH GRAIN HARVESTERS

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Introduction

A large share of mechanization costs in total crop production costs [10] induces one to take actions in order to decrease these costs. This includes a selection of a proper strategy of farms equipping with tractors and agricultural machines. This issue also concerns te grain harvesters, because the properly chosen strategy of grain harvesters selection decides upon the effectiveness of their usage, as well as it influences the share of harvest costs, and therefore the total production costs [2, 8].

The aim and scope of research

The aim of this research was to evaluate the harvest costs of chosen grains depending on the strategy of farms equipping with grain harvesters.

The scope of research included the economical analysis of three grain plants harvest: winter wheat, rye and winter barley, planted on the total area of 1200 ha, 3600 ha and 6000 ha. The analysis examined the equipping of farms with own grain harvesters and the usage of third-party services.

Methods of research

The calculations of the harvest costs were done for three grain plants: winter wheat, rye and winter barley planted on the total area of 1200ha (3 x 400 ha) and 3600 ha (3 x 1200 ha). It was assumed, that the above mentioned grains are cultivated in an intense method, therefore the crops are high. Therefore, the crop of winter wheat was assumed at 7 $t \cdot ha^{-1}$, rye – 6 $t \cdot ha^{-1}$ and winter barley – 5 $t \cdot ha^{-1}$. The crop of straw was estimated according to the crop of straw ratio to crop of grain, on the base of literature. For wheat the ks was assumed at 0.9, for rye – 1.3, and for the winter barley 0.7, so the straw crops were respectively: for wheat – 6.3 $t \cdot ha^{-1}$, rye – 7.8 $t \cdot ha^{-1}$, barley – 3.5 $t \cdot ha^{-1}$.

The following strategies of harvest were assumed: purchase of own harvesters and resignation of harvesters purchase and use of the third-party service. In case of the purchase of own harvesters, three variants were assumed; variant I: purchase of more expensive harvesters with large capacity and large working width; variant II: purchase of harvesters with lower capacity and lower working width.

Because of the fact, that these analyses did not consider the selection of the harvester's manufacturer, the New Holland's harvester was chosen for the purpose of research. For the variant I, the New Holland CX 8070 harvester was chosen with the working width of the header at 9.15m and the capacity calculated according to the literature [3] of 15,38 $kg \cdot s^{-1}$, while for the variant II, the New Holland CX 8030 harvester was chosen (header – 6.1m, capacity of 12.08 $kg \cdot s^{-1}$).

The estimation of the number of harvesters required in a farm for the two variants of discretionary time was done in the time of harvest, when the grain can be harvested without the need of drying. It was assumed, that in the variant I, the discretionary time of grain harvest, with no need for drying is 100 hours, while in the variant II – 280 hours. These times were established according to the literature. [1].

For chosen discretionary times, the required number of harvesters was calculated resulting in two variants of farms equipping: variant I – the number of harvesters providing the grain harvest without the need to dry in 100 hours, while in the variant II – 280 hours. These times were assumed on the base of literature.

For the chosen discretionary times, the required number of harvesters was calculated, resulting in two variants of farms equipping: variant I – the number of harvesters allowing for harvest without the need of drying, even in a short time of harvest and the variant II – the number of harvesters guaranteeing grain harvest without the need of drying, but in a longer time of harvest, while in the case of short harvest time, there is a need for grain drying.

It was assumed, that in the variant II, in case, where the number of harvesters will not be enough to harvest the dry grain, drying will provide a decrease in grain's humidity from 24% to 16%.

In case of using third-party services, it was assumed that the service provider offers the New Holland CX 8070 harvesters and has the required number of machines to promptly harvest crops even in the unfavourable conditions. The cost of service was assumed on the base of the price lists of service companies. It was 250 $PLN \cdot ha^{-1}$ plus costs of fuel used by the harvesters [5]. The price of the service includes the cost of supplying of the harvesters to the farm and the costs of operators' accommodation.

The number of harvesters required for the farm was calculated on the base of dependency no. 1.

$$n_m = \frac{\sum_{i=1}^{k} \frac{F_i}{A_{p_i}}}{T_{dysp}} \tag{1}$$

where: n_m – number of harvesters [-], F_i- the area of iterated plant [ha], A_{pi} – area capacity of iterated type of harvester [$ha \cdot h^{-1}$], k- number of planted plants, T_{dysp} – discretionary time of harvest[hours].

Next, the yearly use of a harvester was calculated by dividing the number of hours needed for harvest by the number of harvesters in a given variant.

Then, the costs of harvesters exploitation was calculated using the IMBEI method [11]:

$$K_{e_i} = \left(\frac{C_{m_i} \cdot W_{R_i}}{T_{h_i}} + K_{UB_i} + 0{,}02 \cdot C_{m_i} \right) \Big/ W_{R_i} + \frac{(k_{n_i}/100) \cdot C_{m_i}}{T_{h_i}} + 1{,}2 \cdot Z_{p_i} \cdot C_p \qquad (2$$

where: K_{ei} – the exploitation cost of iterated harvester [$PLN \cdot h^{-1}$], W_{Ri} – yearly explo tation of iterated harvester [$h \cdot rok^{-1}$], C_{mi} – price of the iterated harvester [PLN], K_{u} cost of the iterated harvester's insurance [$PLN \cdot year^{-1}$], k_{ni} – repair costs ratio (percen age value of a new harvester's price) [%], T_{hi} – normative use of a harvester in tim [h], Z_{pi} – hourly fuel use by the iterated harvester [$l \cdot h^{-1}$], C_{pi} – price of fuel [$PLN \cdot l^{-1}$].

Then, the yearly costs of harvesters usage, which constituted the costs of ha vest in the variants with no need for drying, was calculated.

The costs of drying of the grain were calculated by multiplying the drying co by the amount of grain, which required drying. The amount of grain, which require drying was calculated on the base of the dependency no. 3:

$$I_{zdos} = Q_{zsr} \cdot \left(F_{sum} - \left(n_k \cdot T_{dysp} \cdot A_{psr} \right) \right) \qquad (3$$

where: I_{dos} – the amount of grain, which requires drying [t], F_{sum} – total area of gra plantation [ha], n_k – number of harvesters required for the harvest in the discretiona time of 280 hours [-], T_{dysp} - discretionary time (100 hours), A_{psr} – the average capa ity of one harvester [$ha \cdot h^{-1}$], Q_{zsr} – the average crop of grain 7.8 $t \cdot ha^{-1}$.

The unit costs of grain drying was assumed at 8 PLN/t/% according to the se vice price [5].

The total costs of drying and total costs of yearly expenditures for harvester exploitation constituted the harvest costs in the variant, where the smaller number harvesters selected for crop in the discretionary time of 280 hours harvested the gra in the discretionary time of 100 hours.

The evaluation of specific strategies was performed according to the decisi tree [6, 7].

One of the tree branches is presented on the fig. 1.

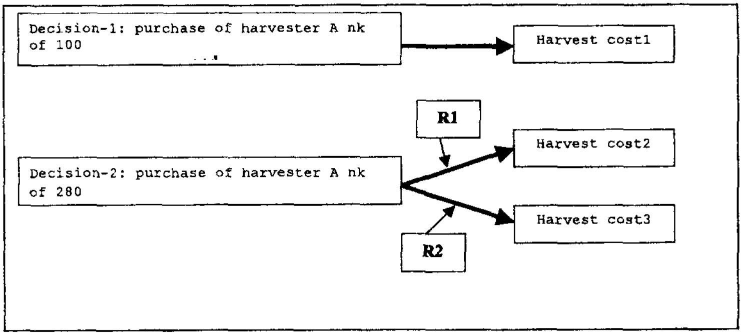

Fig.1. One of the branches of the decision tree in the analysed decision tree

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where: I_{dos} – the amount of grain, which requires drying [t], F_{sum} – total area of grain plantation [ha], n_k – number of harvesters required for the harvest in the discretionary time of 280 hours [-], T_{dysp} - discretionary time (100 hours), A_{psr} – the average capacity of one harvester [ha·h^{-1}], Q_{zsr} – the average crop of grain 7.8 t·ha^{-1}.

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The total costs of drying and total costs of yearly expenditures for harvesters' exploitation constituted the harvest costs in the variant, where the smaller number of harvesters selected for crop in the discretionary time of 280 hours harvested the grain in the discretionary time of 100 hours.

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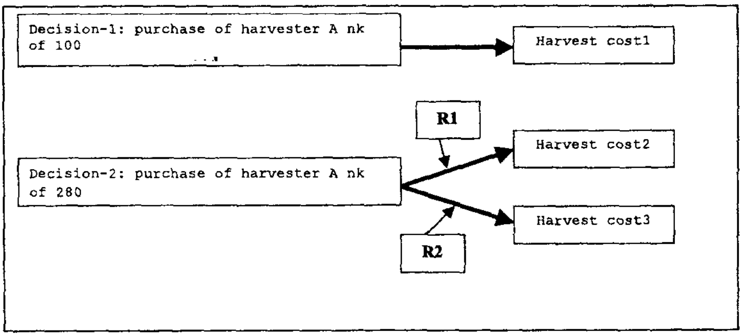

Fig.1. One of the branches of the decision tree in the analysed decision tree

The carried out tree took into consideration 4 decisions on the purchase of harvesters for the farm (2 types) and 1 decision regarding the use of third-party services.

The selection of the best decision using the decision tree was made on the base of the expected monetary value (EMV). It was calculated for each of the decisions separately in the following way [9]:

For the variant, where the number of harvesters allowed for grain harvest in the discretionary time of 100 hours:

$$EMV_i = \text{Harvest cost1}_i$$

For the variant, where the number of harvesters allowed for the grain harvest in the discretionary time of 280 hours

$$EMV_i = \text{Harvest cost2}_i * R1 + \text{Harvest cost3}_i * R2$$

where: Harvest cost1_i – harvest cost for the iterated number of harvesters required for the harvest in the discretionary time of 280 without the need of drying the grain, R1 – probability, that in the time of harvest within the discretionary time of 280 hours, there is no need for drying of the grain, Harvest cost3_i – the cost of grain harvest for the iterated harvester and number of harvesters required for the harvest within the discretionary time of 280 hours with the need of drying of the grain, R2 – probability, that during the harvest within the discretionary time of 280 hours there is a need for drying of the grain.

Because of the lack of data regarding the probability of drying the grain during the harvest within the discretionary time of 280 hours, three variants of probability were assumed for the purpose of calculations. The assumption in the variant I, that such probability is 50%, in the variant II – 80% (pessimistic variant), and in the variant III – 20% (optimistic variant).

Because of the fact, that the grain harvest costs are an expenditure of the farm, the expected values were expressed with the „-„ sign. In this analysis, the most profitable result was presented by the lowest expected value.

The results of research

The results of the performed analysis are presented in the tables 1-2.

In case of the farm planting the above mentioned grains in the area of 1200 ha, the most profitable strategy in the majority of variants is to resign from purchasing the harvesters and usage of third-party services instead.

A similar strategy is profitable for the farms, which plant grains in the area of 3600 ha. However, in the variant where in the expected harvest time of 280 hours, the risk of grain drying is 20%, a more profitable decision is to purchase the harvesters of large mass capacity (in the analysed case: New Holland CX 8070)

Conclusions

When comparing the results presented in the tables, one can find, that in the analysed cases, the purchase of harvesters in the number, which allows for the harvest in the discretionary time of 100 hours, generates much higher costs than the expenditures for the harvest performed by a third – party service (provided, that the number of harvesters of the third-party service provider allows for the harvest in such time) or the costs for the harvest in case of the expected number of harvesters for the harvest in the time of 280 hours (including the costs of drying). The cause of this it the low annual exploitation of the harvesters, resulting from a large number of harvesters required for harvest in short time.

The performed analysis showed, that for the assumed conditions in the case of selected number of harvesters for the discretionary time of 280 hours, with high risk of drying of the grain, the best strategy is also to use the third-party services (of course if these are available) instead of purchasing own harvesters. Only in case of low risk of drying, it is profitable to purchase own harvesters in the number allowing for harvest in the time of 280 hours.

The selection of the proper strategy of farms equipping with grain harvesters has an important impact on the total harvest costs. However it requires the risk evaluation of occurrence of favourable and unfavourably production conditions. These evaluations can be obtained using the statistical methods and expert evaluation method.

Аннотация:

Представлено влияние стратегии обеспечения фермерских хозяйств зерноуборочными машинами на стоимость убранного зерна. Показано, что при выборе уборочных машин для сельскохозяйственных целей целесообразней не покупать уборочную технику, а пользоваться услугами сторонних организаций. Также доказано, что более выгодным является покупка небольшого количества зерноуборочных машин, несмотря на увеличение срока уборки урожая и риска необходимости просушки зерна в случае короткого периода уборки, чем приобретение большего количества зерноуборочных машин, позволяющего обойтись без просушки зерна.

Summary:

The influence of the strategy of equipping of farms with harvesters on the costs of grain harvest has been presented. It has been showed, that during the process of selection of harvesters for the farm purposes, it is worth considering not to purchase harvesters and use the third-party services. It has also been indicated, that it is more profitable to purchase a small number of harvesters allowing for the harvest in a longer discretionary time with the risk of drying grain in case of short harvest time, than to purchase a larger number of harvesters, allowing for a short time harvest without the need for drying the grain.

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