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Technological, economic and methodological aspects of corn grain harvesting and preservation

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Abstract: *Technological, economic and methodological aspects of corn grain harvesting and preservation.* The study analyses issues related to production and harvesting of corn cultivated for grain and various forms of preservation: in the form of dry grain, CCM and LKS. It presents results of investigations and analyses undertaken by various authors as well as own investigations aimed at determining operational and economical input during the preparation thereof. The conclusion from the investigations and analyses is that production of grain and CCM for silages requires the least energy (about 30 GJ·ha^{-1}), while production of whole dried plants requires the most energy (133–176 GJ·ha^{-1}). It is, moreover, emphasised that further investigations into energy input are required, especially with respect to the structure thereof and influence of particular energy streams onto corn production efficiency. The analysis included exemplary mathematical models concerning optimisation of the process of production, harvesting and preservation of corn grain and cobs.

Key words: corn, grain, harvesting, preservation, investigation, technology, modelling

INTRODUCTION

In our climate zone, corn is the most important fodder plant. Continued growth in the area of corn cultures in Poland, in particular with respect to corn cultivated for grain, proves enormous demand for corn in connection with production of fodder and in energy related purposes [Sęk et al. 2000, Podkówka and Michalski 2003, Dubas 2004, Podkówka 2005]. Much higher crops of corn in Poland than of capitulum plants result from implementation of correct principles of agricultural sciences, adapted to local environmental conditions, as well as use of modern means of production, including in particular fertile and sufficiently early hybrids [Borowiecki and Machul 1997, Sęk et al. 2000, Dubas 2004, Waszkiewicz and Kacprzak 2012]. This allows versatile utilisation of corn, which plays the most important role as high energy fodder suitable for feeding all groups of animals [Podkówka and Michalski 2003, Podkówka 2005]. Diversified directions in the use of corn for fodder related purposes may be distinguished in Poland: whole-plant silage, grain and cobs (LKS or CCM).

Production of silage from whole chaffed corn plants is reasonable, as it uses elements of the whole plant and fodder produced in this way constitutes the basis in the feeding of ruminants [Podkówka and Michalski 2003, Gach and Kowalski 2010].

Other forms of preservation are more versatile, including in particular grain, as the most valuable nutritional elements of corn are concentrated in the grain which is an indispensable component of state of the art concentrates for swine and fowl [Sęk et al. 1994, Dubas 2004, Podkówka 2005].

The most common form of corn grain preservation is high temperature drying to the required humidity level [Sęk et al. 2000, Szyszło and Janowicz 2002, Eckl 2003, Janowicz 2007]. Issues related to corn grain drying have enjoyed much attention in Western Europe and the USA in recent years. A tendency to modernise traditional chamber dryers is noticeable. Apart from changes in the design of dryers resulting from the need to increase their throughput and efficiency, attempts are undertaken to improve the quality of dried grain by controlling the drying process. Efforts aimed at maximum reduction of thermal and electrical energy consumption are observed [Szyszło and Janowicz 2002].

Wet reservation may be an alternative to grain drying, particularly if the grain is used as fodder at the local farm or as raw material in bioethanol production [Płonka 2002, Zielińska et al. 2008].

Grain silage may be used to feed ruminant animals, provided however that it requires crushing in crushing mills whose operation is based on the so-called Mursk method [Płonka 2002, Chlebowski et al. 2006, Chlebowski et al. 2008, Gach et al. 2011].

Corn may also be cultivated for CCM (corn cob mix), i.e. silage from fragmented cobs without pockets, which mainly constitutes fodder for swine [Waszkiewicz 1993, Podkówka and Michalski 2003, Podkówka 2005, Hołaj and Zaliwski 2008]. Another method is harvesting of cobs with pockets, i.e. LKS. Thus, LKS silage ought to be considered volumetric fodder, used only in the nutrition of ruminants [Bespomiatnov 2004, Podkówka 2005].

INVESTIGATIONS INTO CORN HARVESTING

The literature contains investigations focused on machines used in the corn harvesting technology, as well as investigations and evaluation of various technologies of corn harvesting and preservation.

Nowadays, a common corn harvesting method is harvesting and threshing of corn cobs immediately in the field, using classical combine harvesters – with a transverse threshing drum, yet suitably modernised [Gach and Pintara 2000, Gach and Pintara 2003a, b, Bulgakov et al. 2006, Przybył and Sęk 2010], harvesters with a longitudinal drum (Fig. 1a) and special harvesters. Adaptation of combine harvesters to the harvesting of corn is connected with modifications of the threshing and cleansing unit of the machine, and replacement of the harvesting unit with an adapted designed for separation of cobs (Fig. 1b) [Szymanek et al. 2008].

The fundamental criterion in the evaluation of harvester operation are grain losses and severity of damage, directly influenced by the kind of threshing unit and plant humidity. Investigations have shown that grain losses (non-threshed grain, macro- and micro-damage) are lower in harvesters with a longitudinal threshing unit where – as opposed to traditional ones – separation of grain from cobs is mainly achieved thanks to rubbing action of the drum, allowing less severe grain damage [Gieroba and Niedziółka 1994, Podkówka and Michalski 2003].

Wacker and Kutzbach [1992] also referred to a lower share of damaged grain and lower growth in losses in the case of

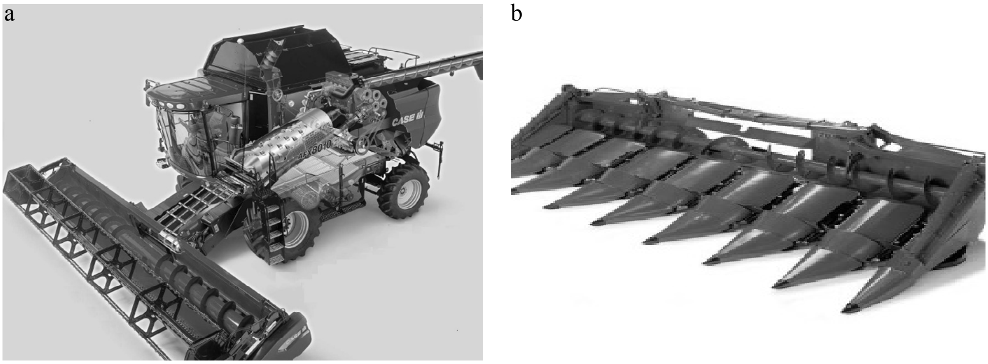

FIGURE 1. Corn harvesting machines: a – harvester with a longitudinal threshing unit and classical harvesting unit, b – corn harvesting unit

throughput increase than in the case of harvesters with a classical threshing unit. As they emphasise, this allows better utilisation of “space” of the harvester with a longitudinal drum than of one with the classical drum. Therefore, as they emphasise, harvesters with longitudinal drums dominate the segment of highest throughput models.

Sęk et al. [1994] conducted a comparative study of the Claas Commandor 228 CS harvester during harvesting of corn for grain. The harvester was equipped with a cob separation unit, without a stalk fragmentation unit. The investigation was conducted during DK-205 variety corn harvest, with fully rape grain, humidity of 32% and crop of 11 $t \cdot ha^{-1}$. Grain losses at the driving speed of 6 $km \cdot h^{-1}$ were 2.28% and, therefore, they were much below the acceptable level. The capacity of 13.3 $kg \cdot s^{-1}$ at this level of loss allowed achieving actual efficiency of 2.67 $ha \cdot h^{-1}$ (29.4 $t \cdot ha^{-1}$) and operating efficiency of 1.72 $ha \cdot h^{-1}$ (18.9 $t \cdot ha^{-1}$). In those working conditions, grain contamination in the collector was only 1.21%. The authors related those results to the results of investigation of adapted Bizon combine harvesters and the ABM-480 special harvester manufactured by Rivierre-Casalis, obtained in different conditions by other researchers. Operating quality indicators (with regard to damage, contamination and grain losses) for the Claas harvester turned out to be the best, with the crop efficiency nearly three times higher than in the case of others.

Investigations covering a harvester with a longitudinal drum [Sęk et al. 2000] involved an attempt to determine the influence of corn cob shaping, harvester working speed and influence of corn variety on the quality of harvested corn and crop losses. The investigation was carried out during the harvest of two corn varieties – Elza and Diana. Influence of working speed onto the level of quality indicators was evidenced. The share of damaged grain increased with speed growth, from 5.11 to 6.88% (whereas the requirements of agricultural science accept 15%). Grain losses decreased along with speed increase: at 3 $km \cdot h^{-1}$, they were about 8%, whereas at higher speeds they were 4.5–5% and, thus, exceeded the acceptable level of 3%. Losses were caused above all by losing cobs, but they decreased along with cob diameter growth. At cob diameter of 40.4 mm, losses accounted for 7.9%, whereas at cob diameter of 46.5 mm – for 1.2%. It was demonstrated that cob diameter had greater influence onto grain losses than the harvester speed. However, no influence of corn variety onto the damage and grain loss level was identified.

On the other hand, Pintara [2000] considered grain losses caused by the threshing unit as an evaluation criterion during investigation of the Bizon Dynamic LX harvester, conducted during the harvest of corn for grain. The investigation was conducted during the harvest of two corn varieties – Melina and Mona. The results evidenced that, for the Melina variety, the highest share in total grain losses were the losses occurred on the sieves as a result of high humidity of corn cob covering leaves, leaves on the stalks and the cobs themselves. During the Mona variety harvest, the highest share in total grain losses were those on the straw walker. Considering much lower leaf and stalk humidity, conditions for separation on the sieves were much more beneficial. Based on statistical evaluation of the investigation results, the relation for grain losses was calculated in the function of throughput (P), characterised with an exponential function. Considering the identified values of the coefficients of regression for the Melina variety, the equation takes the following form: $S = \exp(-4.89 + 0.599P)$ ($R^2 = 88.3\%$), whereas for the Mona variety, its form is as follows: $S = \exp(-5.23 + 0.522P)$ ($R^2 = 91.5\%$). If the acceptable loss level below 1.5% is met, the harvester's throughput during the Melina corn verity harvest was 8.8 kg·s^{-1}, whereas for the Mona variety, it was 10.9 kg·s^{-1}. The difference in throughput values was basically caused by the different corn humidity, as mentioned above.

An investigation of the John Deere 955 harvester was conducted in the village of Parsabad, Ardabil province (Iran) [Mehedi 2014]. The investigation was conducted as a factorial experiment in the system of drawn blocks in four repetitions. There were three levels of the threshing machine speed, i.e. (550, 650, 700 rev.·min^{-1}) and its throughput also had three levels (120, 170, 220 kg·min^{-1}) corresponding, respectively, with the driving speed of (2, 2.75 and 3.5 km·h^{-1}). Based on the results and statistical analysis, it was determined that the driving speed of 2 km·h^{-1} and the threshing unit drum's rotational speed of 550 rev.·min^{-1} generated the lowest losses, below 3%.

Investigations into the harvesting and grain silage production technology with a view to determining the input have been conducted by many authors, using various methods, including the method of cumulated energy consumption, calculation method and technology modelling method.

In the method of cumulated energy consumption, the overall energy consumption index equals to the sum of energy from energy carriers, energy contained in materials and ingredients and energy in fixed (investment) assets, as well as energy constituting the equivalent of human labour.

Szewczyk [1995] presented the results of investigations concerning four technologies of harvesting corn for CCM using different leading machines. Three of them used cob collectors, whereas one used an automotive chaff-cutter equipped with a cob separation adapter. In the light of conducted investigations, the lowest values were identified in the technology with a three-row cob moulder, followed by the one using the automotive chaff-cutter. In the latter case, favourable results of cumulated energy were definitely influenced by lower labour input and lower consumption of mechanical energy than in the other technologies. The final outcome of the conducted investigations was a proposition of three technological variations regarding corn harvesting for individual farms and three variations for large volume farms.

Pintara [2001] launched extensive investigations and analyses of various corn crop management technologies. He compared energy input incurred onto production of corn grain collected according to 10 technology variants and designated for grain, CCM and whole dried plants. He concluded that input depended on the applied production technology, kind of soil and selected forecrop. The highest energy consumption level characterised the technologies of whole dried plant production (133–176 $GJ \cdot ha^{-1}$), whereas the lowest energy consumption level was determined in the production of grain and CCM for silages (about 30 $GJ \cdot ha^{-1}$). To increase the energy efficiency of corn production, one ought to strive to simplify the cultivation and sowing methods. The author concluded that further investigations into energy input, in particular with respect to their structure and influence of particular energy streams onto efficiency of corn production, were needed.

Niedziółka and Szymanek [2001] conducted an investigation at an individual 12-hectare farm. The Bizon Super harvester with a four-row adapter for cob separation was used for harvesting the corn, while grain was dried in a nine--tonne chamber drier with a solid fuel furnace. The crop of humid corn grain fell within the range of 7.5–9.0 $t \cdot ha^{-1}$ (at the average humidity of 31.2%). Based on the conducted evaluation of the energy consumption level of the corn grain production process in the analysed conditions, the input was equal to 5,2 $GJ \cdot t^{-1}$ of dry grain. Direct costs of corn grain production amounted to nearly 80% of the obtained production value. The costs of ingredients and materials accounted for approximately 46%, whereas costs of machine utilisation to 54%.

Tokarev [1989] demonstrated that corn production and harvesting consumes much more energy than it is the case for cereals. For example, production of winter wheat consumes 15.6 GJ (including 55–60 kg of diesel oil), whereas production of corn consumes 23.4 GJ (including 95 kg of diesel oil). Corn harvesting consumes 25% of the total quantity of fuel consumed on production of that plant. The energy and labour intensity of harvesting depends on the applied technological process. Single-stage harvesting with the use of a combine harvester generates lower values of technical and economic indices than two-stage harvesting.

Bespomiatnov [2004] conducted an investigation concerning the process of harvesting corn at the fully rape stage, with grain humidity of 35 to 45%. Harvested cobs with covering leaves were ground by means of stationary grinders with the capacity of 50 $t \cdot h^{-1}$. The ground vegetal material was stored in hermetic silos for production of silage. It was concluded that the energy input contributed per a nutritional unit in the process was several times lower than in the case of harvesting with additional drying of corn grain.

However, Grochowicz and Zawiślak [2012] presented an investigation connected with development of a new technology for processing corn grain crops after harvesting for fodder purposes with the use of a harvester. In the first row, the authors propose crushing of humid corn grain, followed by drying with the use of the convection method. Thanks to applying this method, about 50% of energy used in the traditional process of producing cornmeal can be saved.

The calculation method, sometimes supplied with proposing model process lines, is also applied for determination of costs incurred onto corn harvesting and preservation [Muzalewski 2006, Gach 2009].

Foucek and Polcicowa [1990] presented results of an economic analysis of two process lines designed for harvesting corn, including harvesting for grain and for production of silage from whole plants. In the latter case, next to operations connected with harvesting and production of silage from corn chaff, picking of silage and its feeding to animals was also considered. Despite that, financial outlays in that technology turned out to be lower than in the case of harvesting for grain and, in consequence, it was concluded that production of silage from whole corn plants required lower economic outlays than harvesting and preservation of grain.

In an analysis of three methods of preserving grain in tower silos: non-ground grain, grain with the addition of propionic acid and production of silage from fragmented grain, Eckl [2003] demonstrated that the unit costs amounted to, respectively, 22.7, 33.5 and 25.8 $EUR \cdot t^{-1}$. Although the option with addition of preservatives turned out to be the most expensive, it ensures more stable fermentation and contributes to reduction of losses upon picking the product to be fed to animals [Zielińska et al. 2008].

Investigations concerning the technology of harvesting and production of silage from corn grain in foil bags were conducted at the Department of Agricultural and Forest Machinery of Warsaw University of Life Sciences [Chlebowski et al. 2008, Gach et al. 2011]. Their objective was to identify the operating indicators and economic outlays. The investigations were carried out at two farms with a different area and grain crop level which was equal to 7.92 $t \cdot ha^{-1}$ at the first farm and 14.7 $t \cdot ha^{-1}$ at the latter. In both cases, harvesting was performed in a similar manner, using suitably adapted CLAAS MEGA harvesters, but the major difference was connected with the manner of performing the crushing operation and storage of grain. At the first farm, grain crushing was performed using a MURSKA crushing mill, and the crushed grain were transported in a universal trailer with a tractor and unloaded into the hopper of the AG-BAG G6700 silo press which filled the foil sleeve [Chlebowski et al. 2008].

On the other hand, crushing and bag filling at the second farm was performed by one machine equipped with a NC4210 roller crusher manufactured by New Concept, powered by power take-off of the Ursus 1634 tractor [Gach et al. 2011].

As a result of performed investigations, unit fuel consumption at the first farm was determined at 5.17 $kg \cdot t^{-1}$d.m., and at 5.36 $dm^3 \cdot t^{-1}$d.m. at the second farm. Labour intensity at the first farm was identified as 1.28 $mh \cdot t^{-1}$d.m., whereas at the second farm – as 0.66 $mh \cdot t^{-1}$d.m.

Based on calculations of economic outlays, total costs including crops, recalculated into dry substance weight, amounted to 189 $PLN \cdot t^{-1}$d.m., and the structure of costs was dominated by harvesting – 92.4 $PLN \cdot t^{-1}$d.m. (49 >0%), followed by loading of grain into the sleeve at 57.0 $PLN \cdot t^{-1}$d.m., accounting for 30.2% total costs. Total unit costs of harvesting and preservation at the second farm amounted to 142.1 $PLN \cdot t^{-1}$d.m., with the highest share of harvesting – 48.7 $PLN \cdot t^{-1}$d.m. (34.2%), followed by grain crushing and loading into the bag – 47.7 $PLN \cdot t^{-1}$d.m. (33.7%).

Noticeably, the identified operating and economic indicators turned out to be diversified because of the above factors (diversified course of the technological process and size of corn grain crop). However, in both cases the highest costs are generated by harvesting, which is due to high costs of combine harvester's depreciation. Reduction of outlays may be achieved by improved organisation of work as well as correct selection of machines and equipment making up the process lines, mainly in terms of efficiency, which is also emphasised by Csermely et al. [2000].

TECHNOLOGY MODELLING

Technology modelling comes down to a twofold approach:

- modelling of the whole corn production process;
- modelling of particular operations and activities, including harvesting and preservation.

Niedziółka and Siarkowski [1993] developed an algorithm allowing selection of the most beneficial technical and technological solutions for corn grain production. Computerised optimisation of corn grain cultivation and harvesting first checks the operating capabilities of machines and tools within the assumed agrotechnological time. That stage is followed by selection of the source of energy for particular tools and machines and, eventually, the labour and energy input is determined as well as production costs for the selected solution.

Works conducted at the Institute of Soil Science and Plant Cultivation in Puławy, focused on corn production modelling in different variants and considering diversified corn production optimisation criteria, deserve attention.

Zaliwski and Hołaj [2006] claim that obtaining the best possible economic result of corn cultivation for grain depends on proper balancing of the value of production and costs, which depends on the following factors: proper selection of the variety (crop size, risk of non-raping), corn fertilisation (costs of fertilisers), harvesting and drying of grain (costs of energy). In order to achieve high efficiency (including high expected direct surplus), corn cultivation for grain ought to be located in areas characterised with favourable thermal conditions, whereas in the case of existing cultures, accurate selection of the variety to match existing thermal conditions is very important. The Zeasoft system supporting the process of decision making in corn cultivation may help in more accurate identification of production outlays, thus leading to more sustainable production.

In another study [Hołaj and Zaliwski 2008], the authors presented a model for selecting a favourable technology of silage production from chaffed corn cobs (CCM). The model allows development of technological variants by substituting individual agrotechnological procedures. The technology selection criteria were the labour outlays and costs of corn production for CCM. A database was created, taking into account – among others – varieties, production technologies and prices. A simulation for three diversified areas (1, 5 and 25 ha) and four fertilisation methods was carried out. It was demonstrated that an important item in the structure of direct costs are the costs of materials, including above all fertilisers.

Siarkowski et al. [1992] specified assumptions for computerised optimisation regarding selection of technical means for harvesting and preservation of animal fodder. The method of obtaining optimum solutions depends on the assumed expected criteria, which may include: minimisation of production costs, minimisation of energy input, minimisation of labour outlays or minimisation of external energy input.

Schueller and Krutz [1989] developed a simulation model for analysing the corn harvesting process with a harvester, assuming maximisation of economic profit as the main criterion. The model considered a number of factors influencing that effect, including in particular: grain crop size, market grain price, cultivation area, harvesting time, harvesting method, grain humidity, crop size variability, costs of drying and harvester purchase price. Simulation investigations were conducted in order to identify the best harvester operation strategy from the economic point of view. As a result of performed simulations, it turned out that work at a variable driving speed of the harvester aimed at maintaining a constant stream of cereal mass flow, i.e. at a constant throughput of the threshing unit, is economically more beneficial than work at a constant speed in the continuous movement of the machine.

Maung and Gustafson [2013] examined the influence of random harvesting time of corn for biomass, in terms of the criterion of achieving the maximum potential net income. Using mathematical models, they conducted simulations considering the possible agrotechnological period of corn plant harvesting taking into account the conditions in North Dakota, USA. Using mathematical programming models, three technologies of corn plant harvesting were analysed: 1 – grain only harvesting; 2 – single-stage grain and cob harvesting; 3 – separate harvesting of grain with the harvester and harvesting of hay using a press forming large cubical bales. The structure of mathematical models included income from sales of commodities, including all components, namely: grain, cobs, hay – depending on technology, as well as fixed and variable costs. Costs of corn harvesting assumed for the simulation amounted to, respectively: 70.89 USD·ha^{-1} for grain, 189.6 USD·ha^{-1} for grain and cobs, 127.14 USD·ha^{-1} for grain and hay (grain: 70.89 USD·ha^{-1}, hay: 56.25 USD·ha^{-1}); the costs of hay harvesting included raking and grinding. The criteria of income optimisation for four different agrotechnological periods considered: possible operation time of machines, working time, plant crop (grain, cobs, hay – depending on technology) and field area which may be used for cultivation purposes. The investigations [Maung and Gustafson 2013] demonstrated that farmers were able to achieve the maximum profit from production of corn for biomass within a short time in the case of the first technology, i.e. grain harvesting by means of a harvester. Harvesting of grain and cobs ensured lower net income, mainly because of lower efficiency of the harvester equipped with an additional attachment for corn cob processing mounted at the rear. In the authors' opinion, the third technology, namely separate harvesting of grain and hay may be particularly useful to apply in practice, because of the limited agrotechnological time. In that case, farmers aim at the fastest possible harvesting of corn grain by means of a harvester and hey proceed to harvesting hay, if the time at the end of the harvesting period allows. Based on results of the investigation, the authors suggest that harvesting of cobs and hay by companies specialising in harvesting of materials to be used as biomass will be more economical.

The literature does not contain many studies in which technologies related to production of silage from green fodder are treated as a comprehensive empirical system, although identification of its inputs requires a model [Pabis 1985].

The technology of harvesting and production of silage from green fodder includes a number of activities leading to accomplishment of the process using various machines and aggregates allowing achievement of the aim, namely the final product characterised with similar quality despite varying inputs [Gach 2003, 2005]. Familiarity with the inputs allows selection of the correct technology for the given production conditions. Thus, the technology may be treated as an empirical system which may be described using a model of direct relations between key system elements [Kowalski and Gach 2009]. The following elements were assumed as the main system components: tractor (C), machine (M), trailer (P), raking device (R), field (F), road (D) and manner of storage (S). The paper presents the collection of relations between elements of the model, followed by presentation of its structure as logical and mathematical relations. The graph (Fig. 2) supporting development of the simulation model to be used in calculations was created to reflect the relations.

Programmed and positively verified, the model was used for simulation investigations aimed at identifying unit consumption of fuel, labour and costs per unit of area and material weight during harvesting, and with respect to a unit of dry substance weight. Quantity losses

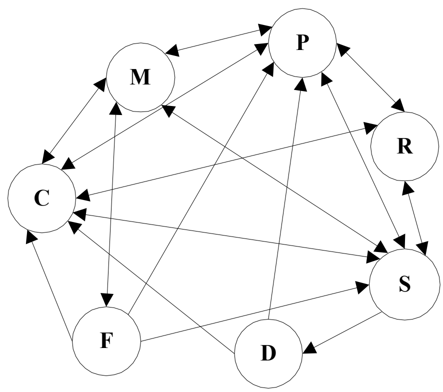

FIGURE 2. Diagram of relations between elements of the system

and – neglected so far – quality losses because of non-ground corn grain which is not digested in the animals' digestive tract were also considered. Outlays on harvesting with the use of different chaff-cutters (automotive and attachable) and different methods of chaff storage (in prisms, silo and foil bag) were determined in the simulation tests [Gach and Kowalski 2009 a, b]. This approach may also be applied to the harvesting of corn grain or cobs.

SUMMARY

Based on the conducted analysis, it may be concluded that corn may be used for fodder in various forms, in particular in the form of dried grain or silage, CCM and LKS. All operations and activities performed in the production and harvesting technology are mechanised and allow assembly of complete process lines characterised with similar efficiency and ensuring continuity of operation.

Harvesting of corn cultivated for grain may be performed using suitably modernised classical harvesters, harvesters with a longitudinal drum and special harvesters equipped with units for separation of cobs and grinding of stalks. The investigations prove that the use of both classical harvesters and those with a longitudinal drum allows achievement of significant throughput and, therefore, high hourly efficiency along with fulfilment of the condition of acceptable waste and acceptable contamination of the grain in the collector.

Analysis of the methods applied in particular technologies, performed with the cumulated energy intensity, calculation and mathematical modelling methods, evidences that they are different. The evaluation criteria include, depending on the method, unit input of energy, labour or costs. Among others, the outlays depend on the applied production technology, kind of soil and forecrop used. Investigations and analyses prove that production of grain and CCM for silage is characterised with the lowest energy intensity (about 30 $GJ \cdot ha^{-1}$) whereas the highest energy consumption occurs in the case of production of whole dried plants (133–176 $GJ \cdot ha^{-1}$). It is, moreover, emphasised that further investigations into energy outlays are required, particularly with respect to their structure and influence of particular streams of energy onto efficiency of corn production.

Analysis of modelling, both regarding the whole corn production process and modelling of particular operations and activities including harvesting and preservation, demonstrates that plentiful valuable information may be obtained regarding material input and costs, to be used by agricultural advisory experts and agricultural producers for optimising the production of corn as well as harvesting and preservation of grain. The use of positively verified simulation models allows justified selection of machines for any predetermined production conditions, or conditions concerning harvesting and preservation. Verification of mathematical models may take advantage of the results of investigations on corn harvesting, obtained in production conditions, conducted at the Department of Agricultural and Forest Machinery of Warsaw University of Life Sciences – SGGW.

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Streszczenie: *Technologiczne, ekonomiczne i metodyczne aspekty zbioru i konserwacji ziarna kukurydzy.* W pracy rozpatrzono zagadnienia zbioru i konserwacji kukurydzy uprawianej na ziarno, jak również różnych sposobów jego konserwacji, czyli poprzez suszenie wysokotemperaturowe, w postaci CCM i LKS. Zaprezentowano wyniki badań kombajnów podczas zbioru kukurydzy, gdzie obok przepustowości uwzględniane są straty ziarna lub całych kolb. Przedstawiono również wyniki badań i analiz podejmowanych przez różnych autorów, jak też badań własnych dla określenia nakładów eksploatacyjnych i ekonomicznych przy zbiorze i konserwacji ziarna kukurydzy. Stosowane są przy tym różne metody, a zwłaszcza energochłonności skumulowanej, kalkulacyjna oraz modelowania matematycznego. Analiza modelowania dotyczącego zarówno całego procesu produkcyjnego kukurydzy, jak też modelowania poszczególnych operacji i zabiegów, w tym zbioru i konserwacji pokazuje, że dostarczają one wielu wartościowych informacji odnoście nakładów materiałowych i kosztów, które mogą być wykorzystane w optymalizacji produkcji kukurydzy. Podkreślono również, że z wykorzystaniem pozytywnie zweryfikowanych modeli symulacyjnych można dokonać racjonalnego doboru maszyn dla różnych warunków produkcyjnych.

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