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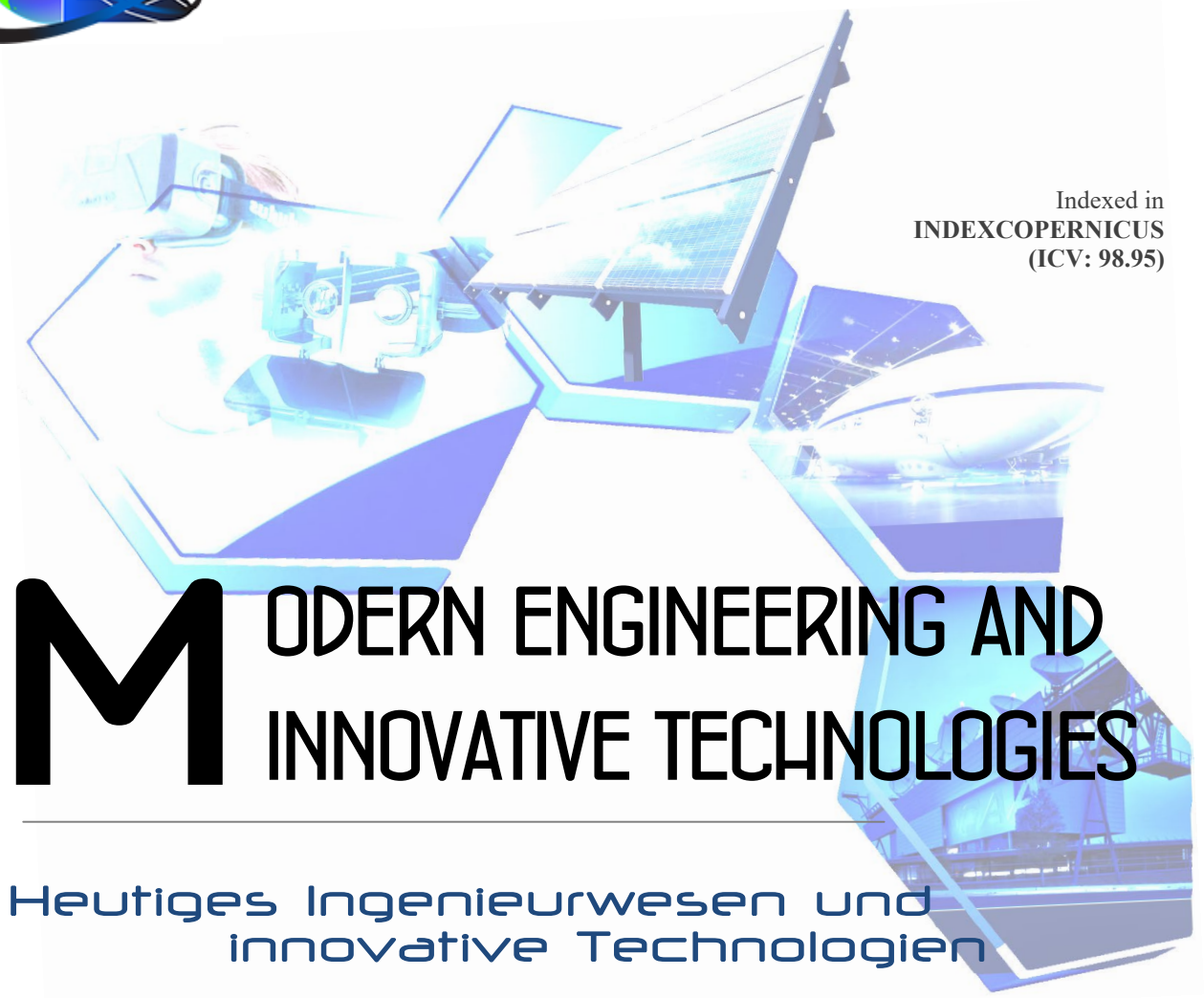

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About the journal

The International Scientific Periodical Journal **"Modern Technology and Innovative Technologies"** has been published since 2017 and has gained considerable recognition among domestic and foreign researchers and scholars.

Periodicity of publication: Quarterly

The journal activity is driven by the following objectives:

- Broadcasting young researchers and scholars outcomes to wide scientific audience
- Fostering knowledge exchange in scientific community
- Promotion of the unification in scientific approach
- Creation of basis for innovation and new scientific approaches as well as discoveries in unknown domains

The journal purposefully acquaints the reader with the original research of authors in various fields of science, the best examples of scientific journalism.

Publications of the journal are intended for a wide readership - all those who love science. The materials published in the journal reflect current problems and affect the interests of the entire public.

Each article in the journal includes general information in English. **T**he journal is registered in INDEXCOPERNICUS.

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Subclass TK /TK5101-6720	Telecommunication
Subclass TK / TK1-9971	Electrical engineering. Electronics. Nuclear engineering
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Subclass T / T351-385	Mechanical drawing. Engineering graphics
Subclass TA /TA1001-1280, Subclass TL / TL1-484, Subclass TE / TE1-450, Subclass TF / TF1-1620	Transportation engineering, Motor vehicles. Cycles, Highway engineering. Roads and pavements, Railroad engineering and operation
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Articles should correspond to the thematic profile of the journal, meet international standards of scientific publications and be formalized in accordance with established rules. They should also be a presentation of the results of the original author's scientific research, be inscribed in the context of domestic and foreign research on this topic, reflect the author's ability to freely navigate in the existing bibliographic context on the problems involved and adequately apply the generally accepted methodology of setting and solving scientific problems.

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All tables and figures in the article should be numbered, have headings and links in the text. If the data is borrowed from another source, a bibliographic reference should be given to it in the form of a note.

The title of the article, the full names of authors, educational institutions (except the main text language) should be presented in English.

Articles should be accompanied by an annotation and key words in the language of the main text and must be in English. The abstract should be made in the form of a short text that reveals the purpose and objectives of the work, its structure and main findings. The abstract is an independent analytical text and should give an adequate idea of the research conducted without the need to refer to the article. Abstract in English (Abstract) should be written in a competent academic language.

The presence of UDC, BBK

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The editors are convinced that violations of copyrights and moral norms are not only ethically unacceptable, but also serve as a barrier to the development of scientific knowledge. Therefore, we believe that the fight against these phenomena should become the goal and the result of joint efforts of our authors, editors, reviewers, readers and the entire academic community. We encourage all stakeholders to cooperate and participate in the exchange of information in order to combat the violation of the ethics of publication of scientific research.

For its part, the editors are ready to make every effort to identify and suppress such unacceptable practices. We promise to take appropriate measures, as well as pay close attention to any information provided to us, which will indicate unethical behavior of one or another author.

Detection of ethical violations entails refusal to publish. If it is revealed that the article contains outright slander, violates the law or copyright rules, the editorial board considers itself obliged to remove it from the web resource and from the citation bases. Such extreme measures can be applied only with maximum openness and publicity.

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UDK 631

SPECIALIZATION OF REAPERS OF COMBINE HARVESTERS
СПЕЦІАЛІЗАЦІЯ ЖАТОК ЗЕРНОЗБИРАЛЬНИХ КОМБАЙНІВ

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Abstract. *The article focuses on the trends in the production of harvesterfs and reapers and their shifting from a certain universalization to the deepening of specialization for a particular crop. It is considered that successful harvesting begins with the correctly selected reaper which provides maximum productivity and acceptable losses. It is substantiated that the choice of a specialized reaper or a universal one depends on the needs of specific farms. Small farmers are trying to buy universal reapers to harvest all crops with a minimum set of equipment. Large agricultural holdings are focused on minimizing losses and therefore are more interested in purchasing reapers designed for harvesting each particular crop, e.g. corn, sunflower, soybeans. The design features of reapers produced by different manufacturers are analyzed. Attention is paid to stripping reapers as an alternative to the classic ones for harvesting grain crops grown using No-Till technology.*

Keywords: *specialization, reaper, harvester, biological features, crops, stripping, losses.*

Formulation of the problem.

According to the observations of market participants in agricultural machinery, the general trend of the "harvester" future is the specialization of reapers. If before the manufacturers sought to achieve a certain universalization in this segment, now there is the opposite process: in-depth specialization and retrofitting of each reaper for a particular crop. In this article, we will look at whether this approach works everywhere, what changes are being made to the reapers, and what this market expects in the future.

Gone are the days when domestic farmers sought to harvest everything in a row with one, often a combine harvester. Specialized equipment for harvesting different crops not only pays for itself but also allows to significantly increase the profitability of crop production.

Combine harvesting machines ensure high-quality harvesting only if their working bodies are selected and adjusted according to the properties of agricultural crops, and the plants are adapted to harvesting machines. The suitability of the crop for combining is determined by the physical and mechanical properties and biological characteristics of plants, as well as their condition during harvest.

In the agricultural sector of Ukraine, combine harvesters of both domestic and foreign companies are used, in particular such companies as MasseyFerguson, JohnDeere, CLAAS, New Holland, Case. Recently, all companies and firms that produce combine harvesters, equip them with special reapers and attachments for harvesting soybeans and rapeseed of their own production.

Analysis of research and publications. Scientists V. Marchenko, V. Sinkov [1], A. Rud, I. Moshenko [2], I. Moshenko, V. Iliiashyk, V. Duhanets [3], D. Voitiuk, V. Dubrovin, T. Ishchenko [4], V. Baranovskyi, V. Bulhakov, V. Haponenko [5], A.

Morozov [6], P. Sysolin, T. Rybak, V. Salo [7] made a significant contribution to the development and research of combine harvesting equipment and research methodology. They developed and researched the designs of the working bodies of modern combine harvesters, wrote textbooks, manuals, and practical recommendations for their use. However, the specialization of combine harvesters is practically absent. Also, the analysis of scientific and technical publications shows that the least information is given about the reapers of combine harvesters of New Holland, MasseyFerguson, JohnDeere, CLAAS.

Formulation of the goals of the article. The purpose of the work is to substantiate the specialization of reapers for a specific crop.

Presentation of the main research material.

Successful harvesting begins with the right harvester because from it the mown mass is sent for processing in the harvester. The reaper is the first technical and technological system that "meets" the crop during its harvesting in the mode of direct combining. And all the work of the harvester depends on how fully, efficiently, and qualitatively it can form a portion of bread mass of certain characteristics (even wet) and stage of ripeness, cut it, feed it on a working platform, and then move it to an inclined chamber. Therefore, it is in accordance with these technological operations and develops the basic design of its systems. In the reapers of different companies and models, they are mostly virtually the same type of operation and design [8].

The harvester reaper, according to its functional purpose, is one of the main technical and technological systems of the harvester and directly affects the quality of the entire harvester. In general, the loss of grain for it in the harvest of standing bread should not exceed 0,5%.

However, without reliable and trouble-free operation of the reaper, it is impossible to imagine the full functioning of the harvester. According to many years of research, about half of all failures of combine harvesters are due to the reaper. The reason - "careful" storage in the open air and improper maintenance during operation.

The trend towards the specialization of reapers is explained by the development of specialization of farms in a particular crop and the desire to get the maximum profit from it. Of course, specialized harvesters designed for a particular crop will collect it with minimal losses, while the percentage of losses due to the use of universal harvesters will always be higher, as their design allows you to collect different crops, but not so well.

For example, a regular combine harvester and a low-cut soybean harvester are very similar, but the latter can harvest soybeans at a height of three centimeters from the soil surface, where the largest number of beans is concentrated (Fig. 1).

Most reaper manufacturers have long been producing special crop reapers. Another issue is that the demand for universal harvesters has always exceeded the demand for specialized, given the desire of farmers to spend money as sparingly as possible.

However, the demand for specialized reapers, of course, is there and it is growing, but it would be wrong to talk about the presence of a pronounced trend towards specialization of reapers. The choice - specialized harvester or universal - depends on the needs of specific farms. Small farmers are trying to buy universal

reapers to harvest all their land with a minimum set of equipment. Large agricultural holdings are focused on minimizing losses and are therefore more interested in purchasing harvesters designed for harvesting each crop: corn, sunflower, soybeans.

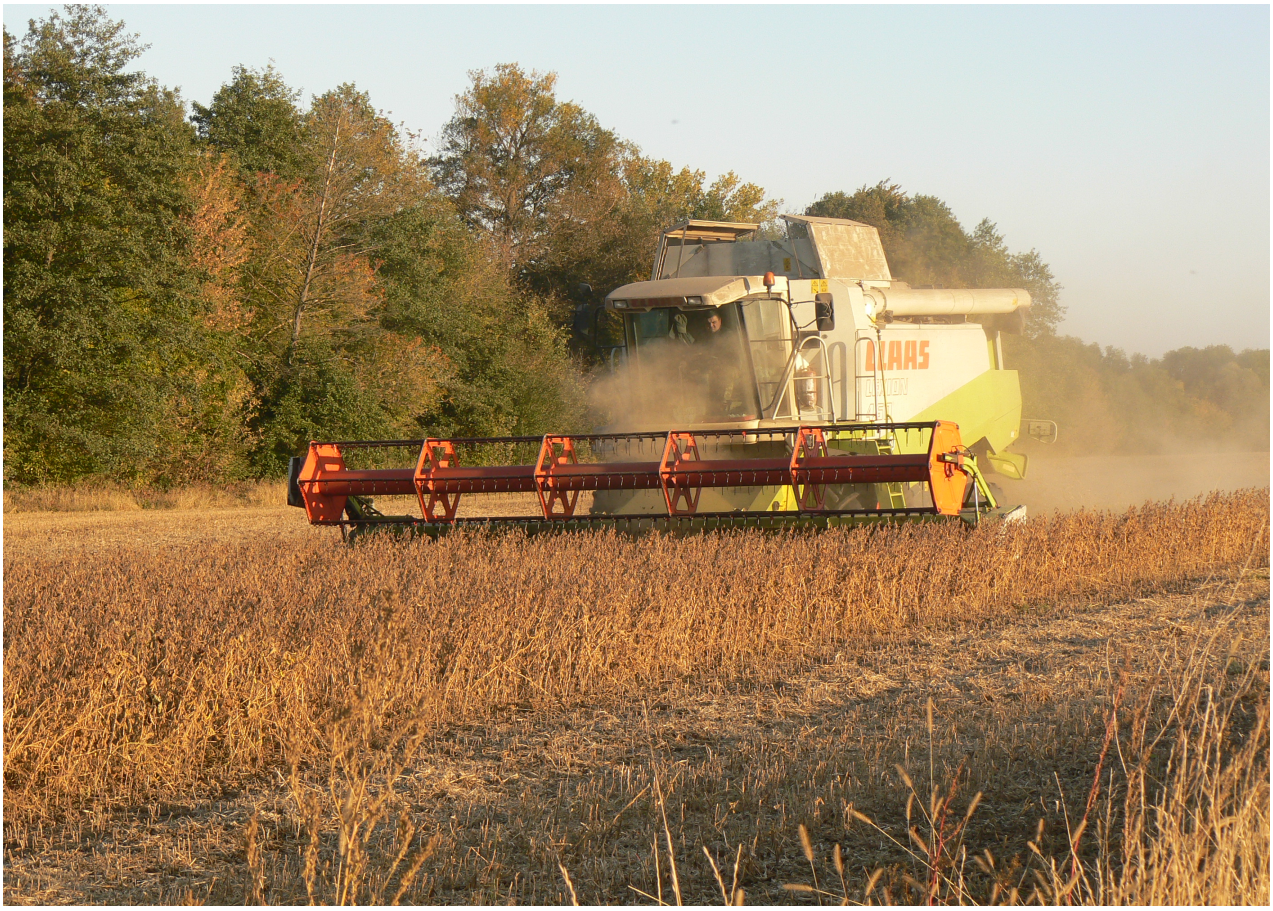

Figure 1 – Harvesting soybeans with a universal reaper

Source: author's proposal

The demand for universal reapers, which can collect several crops with the help of adapters, is not weakening today, but there are more and more specialized reapers to buy - the demand for them has slightly increased in the last few years.

Any farmer when choosing a harvester takes into account many different factors. First of all, these are cultivated crops, the sequence of their harvesting, the area of fields to be worked on, their relief features, yield, the productivity of the harvester fleet. Therefore, to create a universal reaper is not just difficult, but rather impossible and even impractical - it will not provide maximum efficiency for each individual farmer. However, many farmers want just that, but within reasonable limits [9].

For example, the Claas Vario reaper can be converted to rapeseed, although it is a classic combine harvester. This makes sense, as both types of crops are often grown on the same farm, alternating in different fields, so such "universality" is justified. But corn harvesters and sunflowers cannot be made universal.

The Zmievsky's device (ZD) for harvesting sunflower which is hung up on the usual combine harvester, does not suit the majority of agrarians who are engaged in sunflower anymore.

Losses when using the ZP exceed 10%, so in this case, the trend of transition to specialized harvesters is clearly visible (Fig. 2).

Figure 2 – Harvesting sunflowers with a specialized reaper

Source: author's proposal

At the same time, there are universal reapers of another type which by means of a set of re-equipment can be adapted either under corn or under sunflower.

As a rule, for this purpose use a special set which includes the limiting lattices established on the back and lateral boards of a corn harvester, and also special enlarged triangular knives for cutting of the dried-up stalks of sunflower.

For example, corn harvesters from the Italian manufacturer Dominoni - Rock and Kaiman from corn to sunflower are converted by the installation of such triangular knives at the end of the course of the stretching rollers. The Sunflower Harvesting Kit is installed on the Capello Quasar and Diamant reapers. Such models are developed especially for those farmers in whose economy the main areas are occupied by crops of corn and only insignificant - by sunflower.

Today, new maize hybrids with high cellulose content in the stems are becoming more widespread - they tolerate drought well and are more frost-resistant.

However, crop residues after harvesting such hybrids are very long and difficult to decompose and remove nitrogen from the soil. In addition, this stubble prevents the sowing of a new crop, clogging the colters of the drills. Therefore, machines are needed that can grind these stems as much as possible to speed up the rotting process.

For example, following the trend, New Holland has developed a new line of corn harvesters, the design of which corresponds to the working profile of the CR series combines. New 980CR series reapers are designed for harvesting corn with

stalks of different diameters.

The strengthened crushing of stalks occurs in them thanks to four knives-grinders under each extending roller. And their installation at a certain angle to the ground contributes to the destruction of the base of the stems without the threat of damage to the tires. By the way, to protect the tires on these reapers, you can install protective modules Stalk Stomper, which is mounted on the frame, and align the stubble in front of the wheels of the harvester. This significantly reduces the likelihood of punctures or uneven operation of the tires [9].

The Geringhoff Rota Disc reapers are equipped with retraction and shredding rollers, which effectively grind the stalks and a horizontal rotor with fifteen disc blades for efficient stem crushing. The operation of the system in the opposite direction contributes to the creation of a very short, uniform corn stubble, significantly increases the efficiency of grinding and splitting into fibers, which provides optimal rot of the mass of the stems.

On the new reapers of the Optigep company - OptiCorn, OptiCorn Lux - up to 90% of the chaff received in the course of crushing has the size to 6 cm.

An indisputable advantage in transportation is the folding corn reapers. Due to this, the harvester can move on general-purpose roads without removing attachments. Such designs have already become the standard all over the world. Geringhoff's line of complex reapers is one of the largest on the market. It contains models up to 24 lines long. The assembly process is carried out at the touch of a button and is carried out in just 1-2 minutes, without requiring the operator to leave the cab.

Demand for corn reapers will continue to grow. Despite the decline in grain prices, corn will not stop growing, as it is an important feed component, a promising crop for the development of poultry and livestock, the rise of which is now observed.

Corn is one of the most promising crops in the world. And reaper manufacturers, understanding the trend, update and improve the line of their special units. For example, Corio corn headers (for Claas combines) have been improved. The changes affected the shape of the cobs and are designed to provide a delicate supply of plant mass. New CornFlow corn headers have also appeared on AGCO harvesters. They are produced by AGCO's global partner Capello. These are models CF 670R, CF 675R, CF 870R, CF 875R. They are designed for harvesting corn with a row spacing of 70 or 75 cm, have a width of 6 or 8 rows, and cobs with quadrangular rollers, adjustable counterplates, and end stars made of polymer, which provides high performance in different harvesting conditions [9].

Anti-wear plates are installed on the plastic covers of the cob separators as standard in the new CornFlow headers. They are located in the busiest place where the stems and cobs pass and reduce the wear of the lids themselves. Additional shredders mounted in the rear of the feed rollers provide more thorough grinding. Side augers, which are also included in the basic specification, improve the supply of fallen stems.

The Hungarian manufacturer Optigep has relatively recently updated its line of corn reapers. The new OptiCorn Lux reaper has an identical hub base with the reapers of the German manufacturer Geringhoff and is a product of a joint Hungarian-German development - Optigep KFT and Walterscheid GmbH. The new model uses

the latest technical solutions in the construction of the frame. Namely, in order to reduce the weight, together with the German company Walterscheid GmbH, the drive system of the gearbox with an aluminum alloy housing was developed, and the design of the frame was changed to a lightweight one.

The result of such technical solutions was a 10% reduction in the weight of the OptiCorn Lux compared to the previous model.

The new generation of Oros Cornado corn reapers has changed the shape of the rollers that stretch and break the stems - they have become square. But in addition to the four sharpened edges on the knives, they also have four feed edges that interact with the permanently installed anti-cutting plates (preventing the winding of the stem-weed mass). This made it possible to significantly increase the working speed of assembly. The needle bearing of the tip, which required constant lubrication, was replaced by two closed-type roller bearings, which do not require maintenance. Another advantage of Oros reapers is the ability to flexibly adjust the row spacing in a wide range, which allows you to work in the fields with any sowing of corn [9].

The well-known Italian company Olimac produces 4-16-row corn reapers of solid or folding design. Olimac got the first positions thanks to the successful design of its reapers, which allows to harvest corn without losses and work with the minimum amount of money and time spent on maintenance.

The Olimac model range includes a number of proven devices. For example, DragoGT corn headers have several exclusive patented functions. This is primarily an automatic adjusting system of detachable rows and the presence of two shredders with the effect of scissors. These are actually the only reapers in the world, with damping intermittent rows, adjustable automatically.

Accordingly, the amortized rows tear off the corn stalks, and the fork-tearing rows are equipped with a special amortized device that absorbs shocks during the fall of the cobs. The actual detachment of the cobs is smooth, which minimizes losses and makes it impossible to skip the grains between the rows. Thanks to this solution, complete harvesting is carried out without losses, and with high productivity.

DragoGT is equipped with a new large auger (Ø 500 mm – the largest in the segment), which provides a high feed rate of dry corn cobs and lying, thus avoiding clogging and loss of grain cores.

Also, DragoGT is equipped with a unique double stalk shredder with the effect of scissors. Each of them has four blades, endowed with the function of reverse rotation, like scissors, two of them are located on one side, the other two - on the opposite. This device, patented by Olimac, grinds the stems twice as fine: the crushed stems are evenly spread on the soil surface.

Among Olimac products, we should also mention the Drago Gold model, designed for harvesting sunflower and millet. These reapers are available in 6 to 16 rows.

Harvest chains in the construction of the reaper are made with special rubber pins, which gently capture the stems and send them to the conveyor with an auger, which prevents crop loss.

Cut the sunflower with two opposite rotating knives made of high-strength steel. Due to the high speed of rotation, the sunflower does not shake, which prevents the

loss of seeds.

The Drago Gold reaper is equipped with a large-diameter auger conveyor (Ø 500 mm – the largest on the market in this field), which provides the highest feed rate, therefore, clogging and crop loss are impossible. Thanks to this exclusive quality the reaper can be applied with record productivity for harvesting a dry harvest [10].

Another important feature of the header is the presence of a safety coupling, which protects the screw conveyor from damage and wear. Drago Gold - the only reaper for harvesting sunflower, equipped with two safety clutches on each row.

The Drago Gold reaper maintains the optimum working angle of 12° for a full, lossless harvest. Adjustable joints allow maintaining optimum working height irrespective of the height of wheels of the harverter.

Also, the Drago Gold reaper is equipped with the reducer working in an oil bath, without the need of refilling and maintenance.

It is important that the optional Drago Gold header can be equipped with a hydraulic stalk shredder with a minimum absorption blade. If necessary, the shredder can be installed after purchase.

We should pay tribute to the constructors of John Greaves, who do not stop there, but regularly make new improvements to the design of their harvesters, in accordance with the wishes of agricultural producers.

So, we will note the reaper for harvesting of CR-82 corn. It is an 8-row device (a 6-row version is also available), which has a strong frame of rigid construction and a reinforced drive with a coupling. Thus the reaper is facilitated that reduces loading on the inclined chamber of the harvester and reduces fuel consumption.

The mechanism of crushing the CR-82 corn reaper provides a gentle gathering of cobs and effective crushing of stalks. In turn, the cutting height of 7 cm reduces the number of post-harvest tillage operations, and the cutting unit is equipped with a "butterfly" for more thorough grinding of corn stalks.

As well as other units of production of John Greaves, the CR-82 reaper has an increased safety margin. For example, safety couplings protect the gear unit from damage, and 12-class or high-strength steel bolts are installed on the responsible connections. We will add that the novelty is aggregated with any models of domestic and import harvester.

Geringoff is a world leader in the production of corn reapers for various types and brands of harvesters. Geringhoff corn reapers are intended for harvesting corn for grain with the simultaneous crushing of stalks.

The model range of this manufacturer consists of a reaper from 6 to 12 rows with inter rows 70-75, 50-56 cm. There are three types of the crushing mechanism: RSA - with the integrated shredder (roller with knives + an anti-cutting plate), Rota Disc (two giving and transfer rollers + shaft with disk knives), Mais Star: system with a rear arrangement of a crushing rotary knife [10].

The Geringhoff Rota Disc corn reaper includes the benefits of careful cob harvesting and efficient shredding. Two harvesting rotors harvest corn plants, and a cutting rotor equipped with 15-disc knives completely grinds their leaves and stems.

The rotation against the flow of the material significantly increases the efficiency of grinding and splitting into fibers. Also, note the durable self-sharpening

disc knives coated with tungsten carbide.

Horizon Star corn reaper is a system with a rotary horizontal knife. The additional horizontal knife, optimally located and connected by a flange with a reducer, provides the highest quality of crushing. Each mechanism is equipped with an individual friction clutch.

All Geringhoff corn reapers are equipped with a solid frame of a well-thought-out design, a large and powerful auger, and a reinforced drive. Geringhoff developed the technology of automatically folding headers hydraulically many years ago.

The trend of abandoning rows is also gaining popularity. Mainly traced on sunflowers. This allows you to optimize logistics, reduce the number of reversals.

Many farms are now beginning to abandon the rows and move to continuous sowing of sunflowers. This stimulated demand for rowless sunflower harvesters.

Thus, SMH harvesters produced by Berdyansk Reapers can harvest sunflowers in any direction, both in rows and in continuous sowing. Due to the prismatic shape of the lifters, the SMH reapers can penetrate the rows at any angle.

In general, sunflower reapers are becoming more specialized: they are able to work with complex types of crops, such as confectionery (large fraction), or gritty sunflower, which can not be harvested without crushing a conventional sunflower harvester.

For example, Argentine Maizco reapers manage to cope well with such varieties. Thanks to their design, they not only harvest the crop in any direction but also make it possible to cut only sunflower baskets, which reduces the load on the combine thresher and reduces fuel consumption. In addition, it allows you to work at high speeds - 10-14 km/h. On such reapers, the speed of rotation of a reel and adjustment of height under sunflower is regulated during harvesting directly in the field.

Sunspeed reapers, developed by Claas engineers, have a special system for separating the basket from the stems. The sunflower is first captured by the lifters, after which the adjustable guide plate pushes the basket forward. At the same time, the long roller under the cutting device presses the stems down. Due to this, the guide plate and roller do not allow premature cutting of the stem. Only when the basket is already captured by the reel, it is cut. Due to this, only sunflower baskets get to the feed auger, which is then fed into the inclined chamber. This principle of operation provides a reduction in fuel consumption, increase the productivity of threshing and cleaning, reducing the operation of all components [9].

Another super-popular John Greaves model is the SMH sunflower reaper. The unit is offered with various options of the width of capture - from 6 to 9,1 m. In a design of SMH, the simple technical decision of a drive of working bodies with the planetary drive of a knife and a possibility of a complete set with the original Schumacher drive, the strengthened frame, a conic stalk lift, etc. is provided. Lightweight, reliable universal reaper for clean harvesting of sunflower provides excellent productivity and profitability of cultivation.

Note also self-sharpening knives with carbide coating, designed for the long life of the cutting unit and high-quality cutting. Adjusting the angle of the header bar makes it possible to adjust the angle of attack and cutting height. Plastic dividers

provide ease of maintenance, good shock-absorbing qualities, and also resistance against the operation. The SMH reaper adapts to any harvester of import and domestic production.

The Sunfloro Light premium sunflower reaper is distinguished by both lightness and strength of construction. The most popular model has a working width of 11,3 m, which is perfect for working with continuous sowing, mowing fields, and non-standard row spacing, and perfectly copes with the 70 cm row of sunflower.

Note also the proven design of the Sunfloro Classic. The innovative kinematic scheme of the drive of working elements of the Sunfloro reaper many times increases the working life and maintainability of mechanisms after completion of the recommended service life. This is a convenient high-performance reaper.

The Sunfloro Shaft high-speed high-speed reaper is designed for harvesting sunflowers under difficult conditions. Thus, we managed to achieve higher productivity of the model by increasing the tray-lift, changing the angle of the finger bar, as well as placing the gear shaft under it, which allows you to collect only baskets. In addition, the optimal weight of the sunflower reaper allows the harvester to operate at a higher speed and lower fuel consumption.

The Sunfloro Optimo reaper is intended for high-speed harvesting of continuous sowing of sunflower. The model has a broaching gear shaft by means of which the superfluous plant weight does not get to the harvester and only sunflower baskets [10].

The Geringhoff range also includes several types of sunflower reapers. In particular, we will note the Geringhoff Sun Lite model with a working width from 7,6 to 9,1 m.

The Geringhoff Sun Lite continuous cutting reaper has proven itself all over the world. Thus, an efficient and reliable drive of the feed shaft, transport auger, and shear requires only a small power consumption of the harvester.

The special design of Sun Lite reapers provides additional optimization of efforts: in combination with traction force the working angle of inclination leads to that already cut-off sunflower baskets are automatically pushed in the combine that facilitates tightening of the following baskets.

The rounded form and the transport screw with a diameter of 620 mm with independent adjustment create a good basis for high productivity of work at a low speed of rotation.

Another advantage of the Sun Lite sunflower reaper is the use of aluminum components and the precise design of all equipment, which provides maximum stability at low weight. In addition, engineers were able to minimize the number of moving parts, which had a positive impact on operational safety.

The sown areas and volumes of harvested sunflower and corn in Ukraine have increased significantly in recent years, so reapers of these types have become more popular. Soybean is also a promising crop. The recovery in demand for soybean reapers began several years ago, and today this trend continues.

New reapers of many western brands have appeared. For example, Case IH recently launched the 3020 Flex for harvesting peas, soybeans, chickpeas, lentils, and cereals.

The frame of these reapers have a flexible, but strong design and is calculated on the most difficult conditions of assembly. The reaper is equipped both with standard plastic distributors for grain crops and special - for bean or bar distributors.

One of the features of the reaper is the TerraFlex suspension system: the cutting device has a stroke of 76 mm and flexibly copies all the irregularities of the field. For harvesting crops such as wheat, the cutting beam can be rigidly fixed. Features of the reaper design (longer bottom, knives in front of the reel, etc.) allow you to carefully collect soybean pods. The special soy distributor is calculated on the smooth raising of stalks and reduces losses on edges. And the reel can adjust the speed specifically for this culture. Due to the peculiarities of the structure of this plant, the speed of the reel can be reduced. It is also adjustable in height to cut the lower beans.

The 3020 Flex reaper is also great for harvesting peas. If the relief of the field is not perfectly leveled, the grain reaper converted under soybeans will "stick" into the lower layers of the pea mass moist from the night dew and stop the harvester. It is necessary either to reduce speed or to increase the height of a cut and to leave a part of a crop on the field. While the 3020 Flex allows you to harvest the entire pea crop, regardless of the microrelief of the field and the height of the location of the beans, without losing speed [11].

According to some experts, in the production of soybean reapers, American companies have proven themselves well, because, in North and South America, soybeans occupy large areas.

Focused mainly on peas and soybeans reaper and the company John Deere. The 600F reaper also has a reduced reel speed and at the same time increased feed intensity and smoothness due to the large outer diameter of the feed auger (660 mm) with 125 mm turns. And, of course, they are equipped with a flexible cutting device - a system called HydraFlex, which provides the 600F roller reaper with excellent copying of the terrain and high-quality harvesting of the entire crop.

A specialized reaper, of course, allows you to achieve better productivity and quality of harvesting (minimization of losses, reduction of crushing). However, technical solutions are not always limited to the modernization of the reaper. For example, in DF combines, technical solutions allow you to tune in to harvest a particular crop of the energy tool itself, rather than the header (reaper). When harvesting soybeans with Deutz-Fahr harvesters, it is possible to do with an ordinary grain reaper with a working width of up to 9 m. This became possible due to the equipment of the harvester with the system of adjustment of the angle of attack of the reaper: thanks to this system the minimum level of a cut of 4 cm is reached. That is, Deutz-Fahr engineers chose a strategy to upgrade the harvester, but not the reaper. However, the Deutz-Fahr harvester will be able to work with reapers of all known producers that further expand its opportunities.

The active development of such a crop as rapeseed continues. And while Americans have made more progress in specializing in soybean reapers, European companies are delving into the use of rapeseed harvesting equipment, as the future of rapeseed in the light of alternative fuel options in Europe is being discussed quite seriously.

Peculiarities of culture and the development of genetics make rapeseed

harvesting more and more different from grain harvesting. After all, thick at the base of the stem, new varieties, reaching a height of 1,5-2 m, more like a thicket of shrubs than oilseeds or cereals [9].

To assemble this "wall" will soon need a special more powerful cutting machine. And already now in designs of re-equipment of grain reapers under rape, there are powerful lateral vertical knives (sometimes double) giving the chance to make a vertical cut at a passage of the combine on the field (actually clear a way).

Today there are no specialized "rapeseed" reapers; it is, as a rule, additional equipment of grain reapers with a rape table. However, there are all the prerequisites for this: soon such reapers will form a separate group, and their design will have little in common with combine harvesters. An example of this is the new developments of Biso. Such reinforced rapeseed tables also appeared in the range of Ziegler, Zurn, Kemper, and Geringhoff.

By the way, American producers are drawn into the "rapeseed" segment quite actively. In July 2015, John Deere introduced a new series of reapers - 600X, which is positioned as universal - can work on many crops, including fine-grained; she will show decent results when harvesting legumes. However, this reaper is more focused on rapeseed harvesting. Adjusting the crop does not require a special tool: hydraulic extension of the table, installation of side knives on the latches allow you to re-equip the reaper to harvest small-seeded crops in a few minutes. And a specially designed program (Table Length Advisor) "tells" the operator the length of the feed table under specific conditions of assembly (stem height and cut height), and thus he can set it on the monitor of the controlled display, without leaving the cab. The machine itself adjusts the equipment to the required parameters.

Another company, AGCO, offers a unique PowerFlow reaper with active feed, designed for harvesting cereals and rapeseed. Transverse belt conveyors are installed on a wide table, which feeds the beveled mass to the auger. Thanks to this design, this reaper no longer needs a rapeseed table. The only re-equipment is the installation of one or two vertical rape knives to reduce harvesting losses. The wide table also provides a gentle angle of the knife to the surface, which helps to effectively collect the fallen crop - in most cases, even without the use of a stem lifter. Also important is the method of feeding beveled stems: spikelets forward, which ensures their better threshing [9].

For different types of crops and harvesting conditions, New Holland has created a wide range of its own reapers with a width of 6 to 10,7 m with a reel diameter of 1,07 m, a screw with fingers across the entire width, electro-hydraulic reel position adjustment system, automatic reel speed synchronization with combine speed and quick-release hydraulic single-point connection. The Varifeed reaper is used to harvest rapeseed in fields with crops of different heights. The longitudinal position of the knives can be adjusted in the range of 575 mm. The screw with a diameter of 660 mm with deep turns provides fast and uniform giving of the cut weight of even the heaviest crops. Fingers extending across the entire width between the turns of the auger move the grain material down under the auger. To ensure a continuous feed, the fingers can be adjusted in all directions from the cab of the harvester using the electro-hydraulic system [11].

We think that in hilly terrain you need to use a Super Flex reaper. The flexible support of a knife can be bent on 110 mm on an uneven surface, providing a low cut and constant height of stubble. Fully floating auger with deep turns provides fast and uniform giving of the cut weight of the heaviest crops.

The advanced reaper height control system can operate in three modes: the compensation mode uses a pre-set contact pressure on the ground, which is maintained by a hydraulic system for efficient harvesting of crushed or low-growing crops (eg peas and beans); system of automatic adjustment of the height of stubble by means of the sensors located in the lower part of a reaper and hydraulic cylinders of management of a reaper; AutoFloat system uses a combination of sensors that provide repetition of the reaper uneven terrain.

Until recently, harvesting by threshing plants at the root with the help of stripping reapers was rare due to the large losses behind the reaper. Today, this technology is used in many farms to harvest cereals and cereals grown using No-Till technology.

Stripping reapers are not universal harvesting devices and can only be used to remove certain crops. Ear and panicle crops are well stripped, without significant losses. Legumes may be harvested by stripping with losses in excess of 10%, so harvesting with a stripping reaper bean harvester is unlikely. And sunflower and corn can not be harvested in principle with a stripping reaper [12, 13].

The principle of stripping presupposes that high-quality threshing of plants takes place in a semi-open environment. In this case, the seeds separated by stripping move in the open space in a given direction in the middle of the reaper and settle there without loss. Such stripping conditions are possible only if the inflorescences of plants are compact and located at the end of the upper part of the stem, ie in an area close to open space. These requirements are met primarily by ear and panicle crops, such as wheat, barley, rye, oats, triticale, rice, sorghum, flax, and many other similar crops.

If the inflorescences of plants are located along the entire stem (legumes) or non-compact (rapeseed), separated after stripping the grain from the bottom of the stem in flight in contact with the stems and significantly deviates from the specified direction of flight into the reaper space, sprayed in different directions and lost.

The fundamental limitation of the number of crops suitable for stripping has led to the use of stripping reapers in cases where other methods of harvesting are accompanied by even greater or equal losses.

Stripping reapers work steadily in a wide range of harvesting humidity. The upper limit of humidity is limited only by the biological maturity of the grain and therefore the stripping reapers collect the grain well with 30% humidity. The lower humidity limit is 12-15%. At lower humidity the connection of grain with an ear weakens and at the mechanical influence of a reaper on an ear additional losses of grain can occur. Nevertheless, due to the earlier start of harvesting by 3-5 days, the total duration of use of the stripping reaper in the harvesting campaign is longer than in traditional reapers.

The revival of the stripping reaper occurred in the second half of the XX century. Understanding by scientists and engineers of all the limitations in the

development of traditional combined harvesting has led to the creation of alternative methods. Threshing at the root is considered to be the most promising.

Academician of the Ukrainian Academy of Agrarian and Technical Sciences, Doctor of Technical Sciences Leonid Pohoriliy wrote in 1934-2003: «High energy-intensive header harvesting technology has largely fulfilled its historical and technological role, and according to the laws of dialectical development, and our forecasts should give way to the principle of combing for the development of high-performance combines of the new generation».

It is believed that the prototype of modern stripping reapers was a comb made by the American K. Bolduin. The main difference of this harvesting machine is the use of an active working body, which was made in the form of a cylindrical drum of the rotor, along with the generators of which were fixed rows of combs. During the rotation of the drum, the combs are immersed in the stem and comb the grain part of the crop.

This principle of action allowed not so much to cut off the ears, as to thresh them. In addition, this technical solution made it possible to collect wet grain crops, work in fields where the stalk has fallen out or is clogged with weeds.

In the second half of the '90s, Shelbourne Reynolds, the United Kingdom, using the developments of the National Institute of Agricultural Engineering NJAE, mastered the industrial production of reapers with the above principle of operation.

Regardless of the British, the same technical solution, but in the early '80s, came the head of the laboratory of harvesting machines of the Melitopol Institute of Agricultural Mechanization now TSATU, Doctor of Technical Sciences Shabanov Petro -2005.

In 2004, under the direct scientific supervision of P. Shabanov, the machine-building enterprise UkrAgro-Service developed, manufactured, and tested The hinged two-drum stripping reaper Slovyanka UAS. Since 2005, the Slavyanka UAS reaper has been mass-produced and used in production, especially in the steppe region of Ukraine, where No-Till technology is widely used.

One of the main requirements of No-Till technology is the even distribution of crop residues after harvesting predecessors. The use of universal classic, as well as specialized for individual crops reapers can not meet these requirements in full. The main part of the residue is concentrated on the strip between the wheels of the harvester. For further redistribution of the remains, it is necessary to apply special units-mulchers, and it is additional expenses [14].

The stripping reaper leaves a stubble after harvesting of ears up to 1 meter high with ideal distribution on the width of the capture of a reaper. This makes it possible to double the moisture reserves, and in conditions of snow three times.

An additional bonus is the reduction of soil erosion, especially wind, characteristic of these regions due to the fact that high stubble during the winter under the influence of wind and precipitation and protects the soil with a thick, reliable layer.

At the beginning of spring sowing, moist soil is almost on the surface not deeper than 1 cm. The soil is loose and structured to the depth of the layer, where the main part of the roots of plants (Fig. 3).

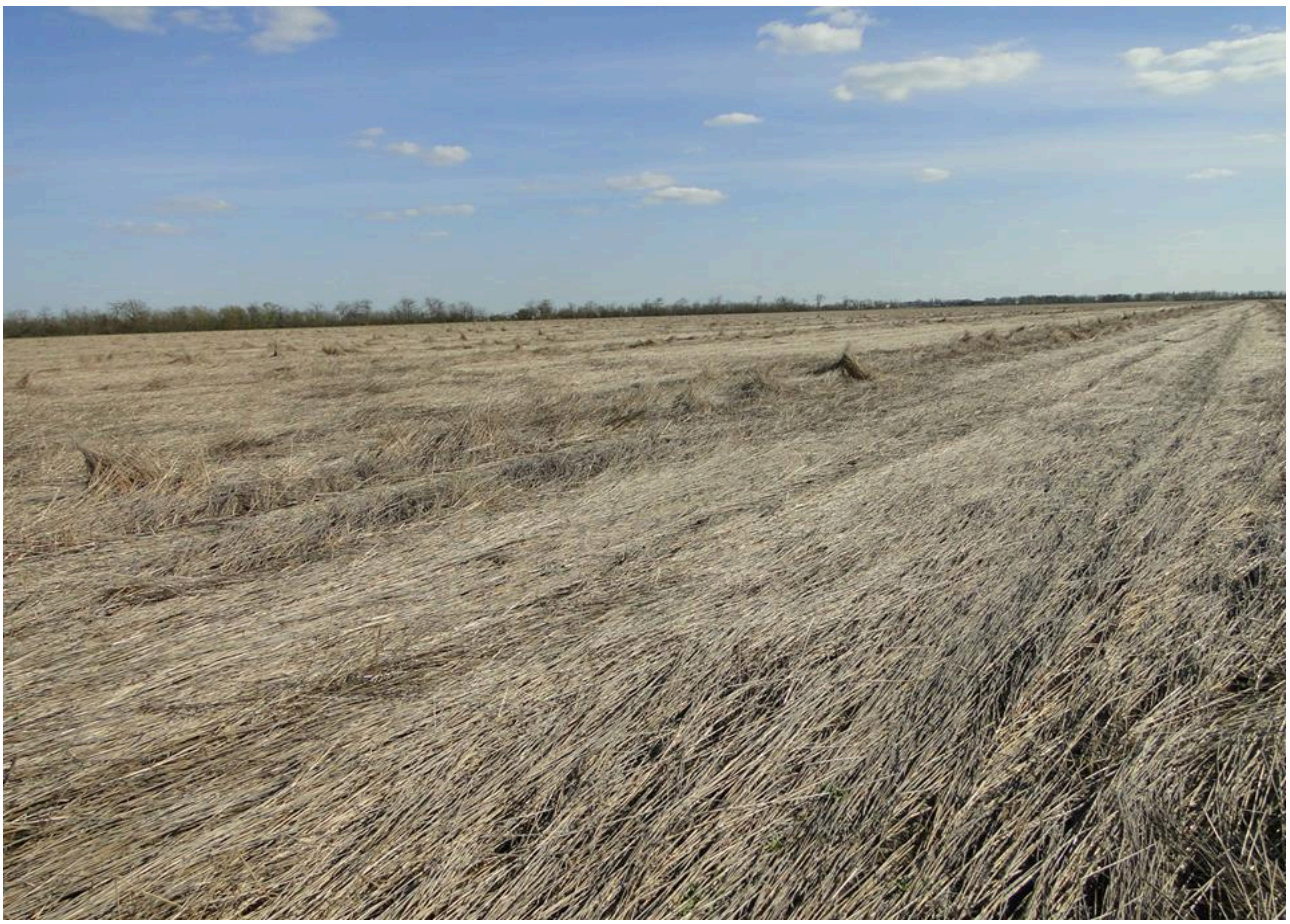

Figure 3 – The condition of the field after harvesting wheat with a stripping reaper in the spring of next year

Source: [14]

Conclusions.

Thus, the trend towards specialization of reapers has already developed in the activities of most leading manufacturers and in the near future, according to many market participants, this trend will continue. The working bodies of reapers of harvesters, their technological process, in general, are designed for the most difficult working conditions during the harvesting of cereals, legumes, soybeans, and rapeseed. The revival of reapers has gained a new vision after the widespread introduction of No-Till technology in the cultivation of cereals and other crops due to the fact that it allows perfectly even distribution of crop residues, retain moisture and protect the soil from erosion.

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Анотація. *В статті акцентовано увагу на тенденції виробництва комбайнів і жаток та спрямування їх від певної універсалізації до поглиблення спеціалізації під кокретну культуру. Розглянуто, що успішне збирання врожаю розпочинається з правильно підібраної жатки, яке забезпечує максимальні продуктивність і прийнятний розмір втрат. Обґрунтовано, що вибір – спеціалізована жатка чи універсальна – залежить від потреб конкретних господарств. Дрібні фермери прагнуть придбати універсальні жатки, щоб усі свої площі збирати мінімальним набором техніки. Великі агрохолдинги зосереджені на мінімізації втрат і тому більш зацікавлені у придбанні жаток, розроблених під збирання кожної конкретної культури: кукурудзи, соняшнику, сої. Проаналізовано конструктивні особливості жаток різних виробників. Приділена увага очісуючим жаткам як альтернативі класичним на збиранні зернових культур, вирощених по технології No-Till.*

Ключові слова: *спеціалізація, жатка, комбайн, біологічні особливості, культури, очісування, втрати.*

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