Researches on Grain Harvesting Machines

Mariana DUMITRU

Lucian Blaga University of Sibiu, Romania
B-dul Victoriei, no.10,Sybil, Romania
E-mail: mariana_dumitru2001@yahoo.com

Abstract. The purpose of the paper is to present some researches made on the mechanisms of the combine for cutting, feeding and threshing. There are presented the floating cutter bar, the combine with a spike-tooth cylinder and rotary separation, the combine with dual threshing and separating rotors.

Some of the adjustments are made on the finger sensors for cutter bar. One of the most important adjustment is that made in order to reduce harvest loss. Forward speed is one of the main factor in optimizing the performance of a combine harvester. The method used in the paper is that of direct observing and measuring made on different component parts of combines.

Keywords: threshing, cutter bar, rotary separation, spike-tooth cylinder

INTRODUCTION

The mechanization of grain harvesting has been a longtime objective of farmers. The cutting and threshing of small seeds by hand methods were extremely tedious. An important early application of steam power was for the stationary threshing, separating and cleaning of food grains. Attempts to develop a field machine to accomplish all the small-grain harvest in one operation dates in the world from the 1830s, but not until after the advent of lightweight, powerful, high-speed internal combustion engines could the reaper, thresher, separator and cleaner be combined effectively into a single field machine referred simple as a combine.

The farm machinery manager is most interested in an economic material efficiency for machines. Small-grain harvesting is a good example of compromise machinery management. If a combine is adjusted to thresh out every grain, the severity of threshing will likely damage the grain and overload the cleaning section with ground-up straw. The material efficiency of the combine is actually reduced. There is also expected reduced income because of the lower value of damaged grain, increased grain loss from the cleaning section and reduced forward speed necessary because of the overloaded cleaning section.

The ability to recognize and evaluate compromise solutions is a valuable trait of the harvesting machinery manager who must understand the detailed operation of the machines, must check their performance and pick up the adjustments and operating procedures that produce the greatest economic return.

MECHANISMS OF THE COMBINES

The mechanisms included in a combine accomplish 5 general functions: cutting, feeding, threshing, separating and cleaning.
The cutting operation is accomplished with a cutter bar and a reel. The reel may be a plain bat reel or a pickup reel with cam controlled teeth. A pickup reel can be effective in lifting lodged crops above the cutter bar.

A floating cutter bar is illustrated in fig.1. This cutting device is loosely suspended beneath the combine header and flexes to follow the contour of the ground. The low cutting height, 2.5 cm is especially advantageous in harvesting soybeans. A floating cutter bar is especially valuable for wide-cut combines that are seldom able to maintain a uniform low cut in even the most level of soybean fields.

Windrowing the crop before combining is practiced in many areas. Windrowing is expected to increase the ripening and drying rates of the crop to permit earlier harvest.

The feeding operation consists of mechanisms that distribute and deliver the crop material to the thresher in a steady, uniform flow. A large diameter auger conveys the cut material from the cutter-bar to a central conveyor that feeds the material to the threshing mechanism.

The threshing operation is accomplished with a cylinder or a rotor, working against curved, grated sections called concaves. Material flow is perpendicular to the axis for rotors. For threshing cylinders there are 2 designs:
- rasp bar, at which threshing is accomplished between the rasp bars on the cylinder and the concaves.
- Spike tooth, as it is shown in fig. 2, at which threshing takes place between the teeth of the cylinder and the teeth of the concaves. This design provides an aggressive threshing for rice and crops having tough straw and weeds.
The separation operation removes the threshed grain from the mixture of plant parts that comes from the threshing section. The straw walkers are long units mounted on 2 crankshafts. Rotation of the crankshafts agitates the material and the heavier grain falls through a grate on the bottom pan of the straw walker. From there, the grain slides down to the grain pan. Most of the threshed grain is expected to escape from material other than grain at the concave grate. The separating mechanisms are used to take out the last 20% of the threshed grain entrapped in straw, pods, husks or stalks. In fig.2, a rotary separator replaces the straw walkers.

In fig. 3 are presented rotary combines, which use large single or double rotors to replace both the threshing cylinder and the separator. The rotor is enclosed by a cylindrical grate that has vanes to direct flow in an axial spiraling motion out the rear of the machine. The centrifugal force imparted by the rotation causes a force on the kernels many times greater than the force of gravity and produces rapid separation of grain from the material other than grain. The physical volume required for the separating operation of a rotary combine can be substantially less than that for the traditional straw walker design of similar capacity. Also, the rotary design may damage grain less.
Fig. 3. Combine with dual threshing and separating rotors

The cleaning operation is accomplished in the following ways:
- by screening out the larger particles with chaffer and sieves
- by blowing out the lighter particles with a fan blast
- by screening out the smaller particles in a re-cleaner

A cleaner is expected to remove all material smaller than the grain harvested. It may be a device as simple as a fine screen around the clean grain auger or a screen along the bottom of the clean grain elevator or as sophisticated as a powered auger device located above the grain tank.

Adjustments made to combines

The most adjustment made to combines are those for reducing loss. The losses relating to the combining of grains are as follows:
- shatter loss
- cutter bar loss
- threshing loss
- separating loss
- cleaning loss.

Shatter loss is not the responsibility of the machine other than that of the capacity of a particular machine may not be high enough to harvest all the grain before a significant amount of grain is lost due to wind action, to bird, rodent and insect damage and to the natural tendency of the crop to shatter as it dries.

Usually, cutter bar losses are greater than other losses for the correctly adjusted, direct-cut combine.

Improper reel adjustment is one of the greatest sources of loss when harvesting cereal grains. In fig.4 are presented data over a 3 years period of barley harvesting. The top 2 solid curves show the effect of having a fixed-bat reel too low and too far forward for upright grain. The heights indicated are for the lowest position of the bat or tooth tips of the pickup reel with reference to the level of the cutter bar knife. The distance forward is the horizontal distance between the reel axis and the tips of the cutter bar knife sections.
The concave clearance depends on the amount of throughput as much as on the physical size of the seed. In some instances, good threshing is obtained by widening the concave clearance and then increasing the throughput.

The severity of threshing is increased with increased cylinder speed and decreased concave clearance. Such adjustments are indicated if the crop is tough because of high moisture content.

Forward speed is probably the most important factor in optimizing the performance of a combine harvester. Many experiments made by the author have determined that total losses increase rapidly as forward speed increases. Because of overloading, rack losses, especially, rise with an increase in speed. The increase in rack losses appears to be directly proportional to speed and can amount to 4% of the total yield as speed is increased from 3.2 km/h to 5.6 km/h in heavy-yielding grain.

Moisture content of the crop is a very important item in deciding when to combine. That is why the time of harvesting with combines is a major decision for the machinery manager.

CONCLUSIONS

Harvesting with combines is one of the most used operations in a modern agriculture. That is why, the researches made for improving different parameters of these machines are very important.

The results of the experiments presented in this paper refer especially to the mechanisms included in a combine, the adjustments that can be made for obtaining better results, particularly for reducing loss, the factors that increase or decrease harvest losses and the decisions which must be taken by the machines manager in order to obtain the best results.

REFERENCES

1. Hunt, D. (1995), Farm power and machinery management, Iowa State University, USA