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COMBINE MODIFICATIONS DISPUTED

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Introduction

Mr. Ray Stueckle of Colfax, Washington has recently held a series of combine clinics in the prairie provinces. He has also been promoting sale of his booklet on combine settings and has written several articles for the farm press detailing modifications which are supposed to improve combine performance. The main thrust of Mr. Stueckle's story is that combine manufacturers don't know what they are doing and that farmers are losing millions of dollars annually because of faulty combine design.

Mr. Stueckle's combine clinics are entertaining and his story sounds convincing. Unfortunately, he presents few facts and makes no guarantees that his modifications will improve combine performance. Several of Mr. Stueckle's modifications defy logic and are directly opposed to research findings. The purpose of this article is to warn farmers not to expect miracles from Mr. Stueckle's modifications. There are no research results to indicate that any of the proposed modifications will improve combine performance. Conversely, there are research results to show that some of the modifications may reduce combine capacity. It is doubtful if the costs of proposed modifications could be recovered during the life of a combine, as a result of increased performance. It is also obvious that combine manufacturers would long ago have incorporated the proposed modifications had they shown any merit. Finally, it is possible that several thousand dollars may be lost in trade-in or resale value as a result of combine modifications.

Mr. Stueckle's Recommendations

Mr. Stueckle recommends many modifications involving considerable time, labor and machine shop costs. He recommends "trueing" the cylinder to 0.75 mm (0.03 in), building up the concave bars so that they are at least 8 mm (0.3 in) above the wires and forming or machining the concave to give it a radius 3 mm (0.13 in) larger than the cylinder. He also recommends blanking the front one-third of the concave, removing at least every second wire from the rear two-thirds, setting the rear of the concave at "zero" clearance, and reducing the cylinder speed in all crops.

Mr. Stueckle justifies these changes by stating that threshing is by friction (heads rubbing against each other) rather than by impact (cylinder bar striking heads). He suggests that cylinder out-of-round is responsible for unthreshed heads and cracks occurring simultaneously.

The shoe also receives considerable attention. Mr. Stueckle recommends removing windboards, changing fan positions within the fan housing and even altering the shoe hangers. Finally, after performing all these modifications, he recommends careful attention to engine and component speeds, belt tensions and other adjustments in accordance with the operator's manual. While raising points related to proper knife and table auger adjustment for straight combining, Mr. Stueckle makes no mention of windrowed crops, apparently having had little experience in typical prairie conditions.

Research Findings

The following summary of research findings disagrees with Mr. Stueckle's recommended cylinder and concave modifications and leaves grave doubts as to the value of his proposals.

The cylinder and concave serve two purposes, to thresh the grain and to separate the threshed grain from the straw. Grain not separated at the concave must be separated on the straw walkers.

Although Mr. Stueckle suggests that cylinder out-of-round is responsible for simultaneous cracked and unthreshed grain, hard to thresh crops such as Neepawa Wheat always result in a compromise between complete threshing and grain damage. Complete threshing is undesirable if it results in excessive cracking. Likewise, no grain damage is unacceptable if threshing is incomplete. Usually the best that can be accomplished is a setting where the unthreshed losses equal the losses due to cracks. Even so, that is not the whole story, because separation must be considered when making cylinder and concave settings.

High cylinder speed and reduced concave clearance improve threshing, but also increase grain damage. High cylinder speed and reduced concave clearance also increase grain separation at the concave. Increased concave separation reduces straw walker losses in most conditions since less grain is delivered to the straw walkers.

Mr. Stueckle states that threshing is by friction (heads rubbing against each other). High speed movies have clearly shown that threshing is caused by the impact of the cylinder bars on the grain heads. Depending on cylinder speed and concave wrap, there are from five to ten impacts by the cylinder bars on each grain head as it passes through the cylinder.

The function of the concave is to hold the crop so that the cylinder bars can hit it effectively. If the space between the cylinder and concave is too wide there are fewer impacts. Slowing the cylinder reduces the intensity of the impacts.

Most threshing is done by the first impact at the entrance to the concave. Once threshed, the free grain should be removed to prevent damage. This happens if the front of the concave is open to allow the grain to pass through it.

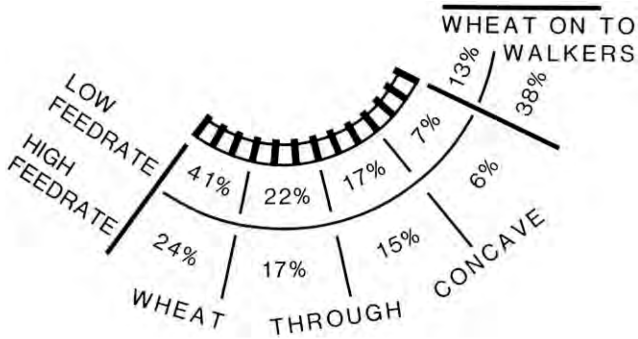

FIGURE 1. Separation Over Concave Length.
(Reed -- University of Saskatchewan -- 1968)

Mr. Stueckle claims that the front one-third of the concave does the threshing while the rear two-thirds do the separation. FIGURE 1 clearly shows that most separation takes place at the front of the concave with decreasing separation towards the rear. The total amount of grain separated at the concave depends on crop conditions, feedrate, concave open area, size of concave openings, cylinder speed, concave clearance, and concave wrap.

FIGURE 2 shows that concave separation is much more efficient in wheat than in barley, and that concave separation decreases with increased feedrate. This explains the lower capacity of a combine in barley, and the resulting high walker losses at high feedrates.

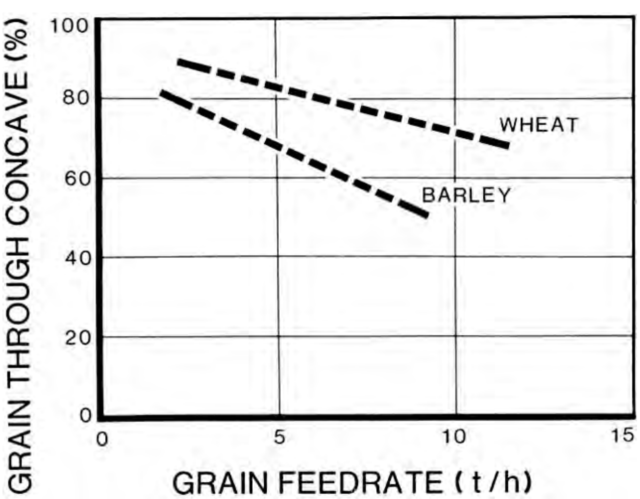

FIGURE 2. Effect of Crop and Feedrate on Separation.
(Reed -- University of Saskatchewan -- 1968)

The total amount separated also depends on the concave open area and the size of the openings making up that area. Openings that are large enough to allow whole or partly threshed heads to pass through will result in these heads having to be returned for rethreshing. If the concave openings are too small, the free grain cannot pass through readily enough and more damage may result as well as less separation. For a wide range of crops, a compromise is needed, to provide good threshing on one hand with minimum damage and maximum separation on the other.

Increased cylinder speed increases separation at the concave, as shown in FIGURE 3. Reducing cylinder speed as Mr. Stueckle suggests, reduces concave separation and increases walker loss. On the average, grain separation at the concave decreases by 1% for every 25 to 30 rpm decrease in cylinder speed, and straw walker loss nearly doubles for every 5 to 10% decrease in grain separation at the concave. Although threshing improves as cylinder speed increases, grain damage also increases.

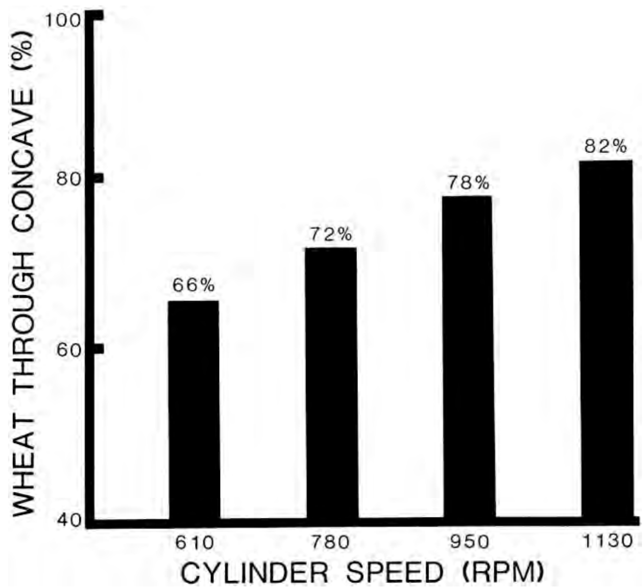

FIGURE 3. Effect of Cylinder Speed on Separation.
(Arnold -- National Institute of Agricultural Engineering -- 1964)

Decreasing the concave clearance improves separation at the concave, as shown in FIGURE 4. In this case, halving the clearance increased separation at the concave by 10 to 20%. Again, threshing improves as concave clearance decreases, but grain damage also increases.

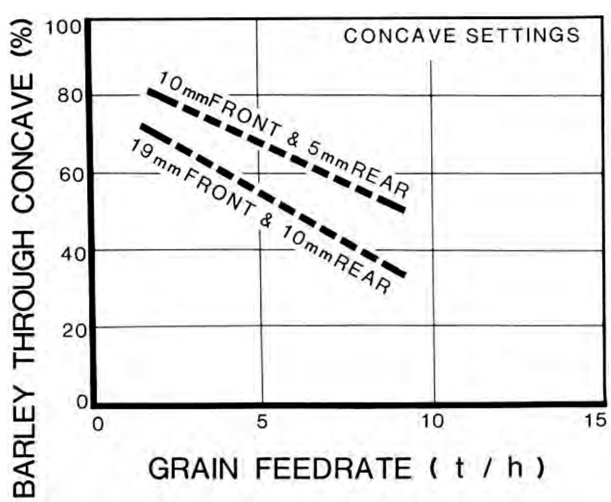

FIGURE 4. Effect of Concave Clearance on Separation.
(Reed -- University of Saskatchewan -- 1968)

Increased concave wrap, up to some practical limit, improves separation at the concave, as shown in FIGURE 5. The net effect is to provide more concave open area, thus increasing separation at the concave. Once again, threshing improves as concave wrap increases, but grain damage also increases.

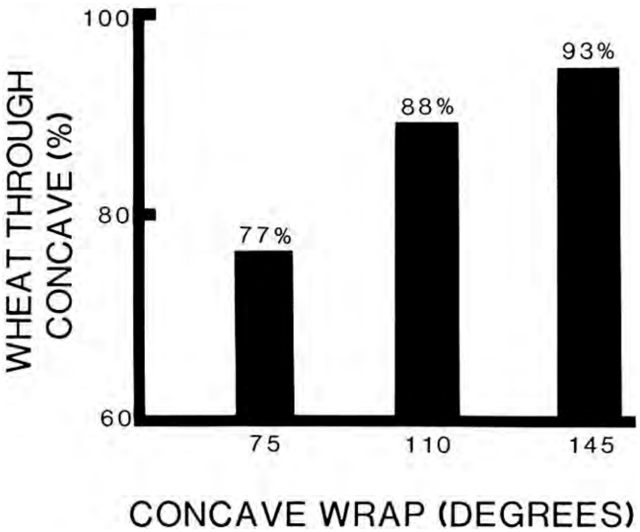

FIGURE 5. Effect of Concave Wrap on Separation.
(Arnold -- National Institute of Agricultural Engineering -- 1964)

Mr. Stueckle presents one remedy for a variety of concaves, which is to blank the front one-third and to remove at least every second wire from the rear two thirds. FIGURE 6 shows a sample of concaves, the wide differences among them, and how the open area changes when Mr. Stueckle's modifications are carried out. Concave open area is increased in only two instances, by less than 10%, and in the other instances is decreased when Mr. Stueckle's modifications are made. For example, carrying out Mr. Stueckle's recommendations of blanking and removing wires on a John Deere 6601 concave, reduces concave open area by 14%. The net result has to be to reduce concave separation and to increase straw walker loss.

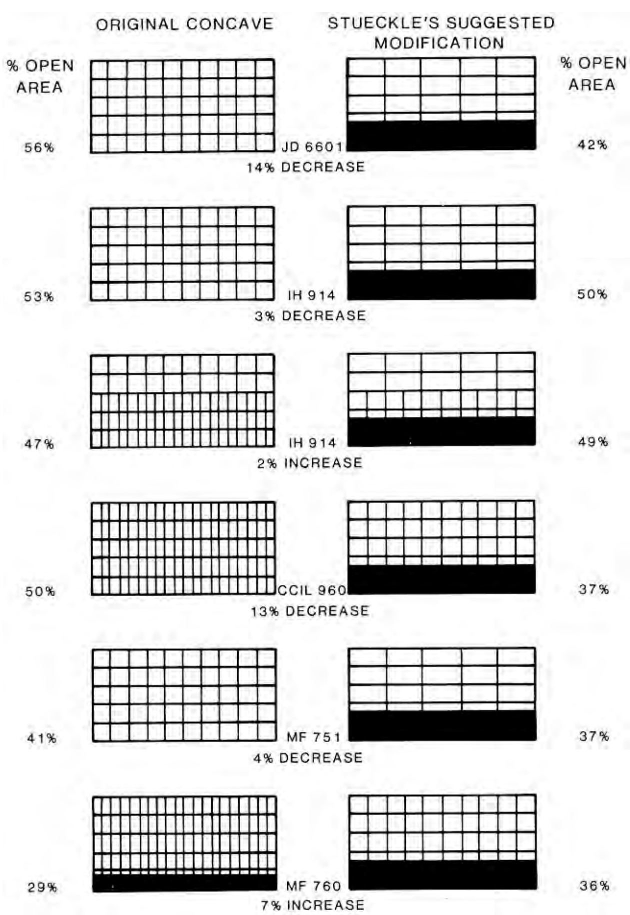

FIGURE 6. Changes in Concave Open Area after Stueckle's Modifications.

FIGURE 7 clearly indicates that grain separation at the concave is greatly reduced when blanks are added, either above or below the wires. Threshing is improved and a cleaner grain sample results, but the reduced concave separation increases straw walker losses. It is obvious, from FIGURES 1 and 7, that blanking the first one-third of the concave, as suggested by Mr. Stueckle, has to severely reduce grain separation at the concave. This can have only one effect, to reduce combine capacity as a result of increased straw walker loss.

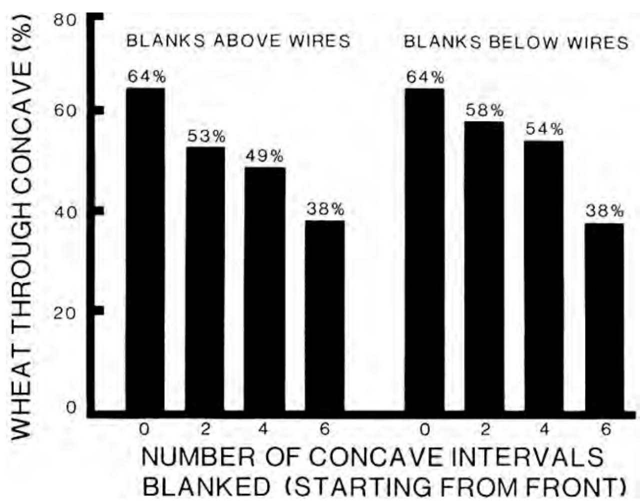

FIGURE 7. Effect of Blanking on Concave Separation.
(Cooper -- Massey Ferguson -- 1978)

Mr. Stueckle places great emphasis on cylinder and concave "trueness". Although precision is desirable, it is costly. The benefits must be demonstrated to make precision worthwhile. In typical cereal grains, no benefit will result from improving on the tolerances found in most combines. Cylinder and concave tolerances, measured as part of the PAMI combine evaluation program, show that cylinder tolerances seldom exceed ±0.75 mm (±0.03 in) and concave tolerances seldom exceed ±0.65 mm (±0.025 in). It must be remembered that when normal cylinder to concave operating clearances range from 3 mm (0.13 in) to 1 2 mm (0.5 in), the precision recommended by Mr. Stueckle is completely unnecessary. In addition, concaves and cylinder bars deflect constantly under Icad, causing the tolerances to vary in proportion to feedrate. Since it is not uncommon for the centre, front bars of a concave to deflect up to 6 mm (0.25 in) at high feedrates, Mr. Stueckle's recommended tolerance of 0.75 mm (0.03 in) is totally unnecessary.

In addition to cylinder and concave modifications, Mr. Stueckle also suggests modifying other parts of the combine, including the cleaning section. Some of the suggestions may be worthwhile for some peculiar condition but may adversely affect the operation for average conditions. Deflector boards or vanes should not be removed from the fan throat or the sieve area. Such parts serve a definite purpose and have been included by the manufacturer because they are necessary for best performance.

More drastic modifications such as changing the sieve motion may shorten the life of the reciprocating parts such as the sieve holder, sieve hanger brackets, and the drive. The additional loading of parts caused by the change in motion may in some cases contribute to rapid fatigue failure. Such failures, of course, are not possible to predict without extensive testing.

In Western Canada, where crops are windrowed, unique problems result which are foreign to straight-cutting areas. Windrowing increases the amount of straw, which reduces combine capacity. Non-uniform or bunchy windrows resulting from improper windrowing cause uneven cylinder and shoe loading.

Non-parallel windrows and those fed off-centre affect the distribu.-tion of grain and chaff across the combine width. Such non-uniform distribution makes optimum operation difficult and some adjustments not effective. Combine performance will be increased by careful windrowing and uniform feeding, but will unlikely match performance in "straight" combining.

Successful combine operators are those who have learned the principles of harvesting and understand the effect of combine adjustment and crop conditions on combine operation. Since combine capacity varies widely from year to year due to changing crop conditions, different adjustments are often necessary. Although Mr. Stueckle's modifications may have some value for certain conditions, dramatic changes in capacity are not to be expected.

In summary, before modifying your combine, you should ask yourself "Have the benefits of these modifications been proven to work in Western Canada; in fact, have they been proven to work anywhere?"

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