Reducing Forage-Chopper Fuel Costs

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Harvesting is among the operations in farming with the highest energy requirements, especially chopping of grass and corn silage. Therefore, diesel fuel consumption is high as well. Thus, potential savings have to be fully exploited. The price for diesel fuel cannot be influenced by the driver, but the level of consumption can be. Even with "small" self propelled forage choppers, daily diesel fuel consumption can be very expensive. At current prices for diesel fuel, a savings potential of 10% creates a significant reduction in the fuel bill.

A variety of factors influence power requirements and fuel consumption of forage choppers. Design of modern, self-propelled harvesters is principally driven by the goal of low fuel consumption. This is especially visible in engine technology. The largest part of the provided engine power is needed to operate the cutterhead. In fact, the power needed for the cutterhead can rise up to 75% depending on conditions. For this reason, it makes sense to concentrate fuel consumption research on this area.

Power consumption of the cutterhead is influenced by a number of different parameters, particularly the forage being cut and its properties. Since other factors are dominant here, there is no possibility for the driver to influence this.

However, the driver can influence the level of throughput, i.e., mass of forage which is chopped per second, which has a corresponding influence on diesel fuel consumption or rather fuel consumption per ton (this indicates how many liters of diesel are required to chop a ton of forage). For this reason, research was conducted by the authors at the University of Applied Science, Dresden, Germany, in collaboration with Busatis Austria, a producer of chopper knives.

Results from the corn silage harvest are shown in Figure 1. Data were analyzed on a per-load basis and consist of weight of chopped material, chopping throughput and associated fuel consumption.



Figure 1. Throughput affects diesel-fuel consumption during corn silage

Results show fuel consumption per ton declines by increasing throughput. Level of throughput influences fuel consumption by up to 20%. Therefore, to increase fuel efficiency, the driver must achieve high chopping throughputs by utilizing large grass swaths or a big corn silage header.

The driver's focus must be the cutterhead. The operator determines fuel consumption by knife sharpness and shearbar-to-knife clearance. Figure 2 shows the importance of these parameters.

Operators know high fuel consumption is caused by dull knives. But only a few drivers know that more cutting energy can be wasted with a large shearbar-to-knife clearance than with dull knives.

Sharp knives, and good clearance from the shearbar, reduce the energy required to chop and and help ensure a good quality of shredded material. However, this maintenance wastes working time and each grinding operation removes material from the knives. Eventually knives are consumed and must be replaced at considerable expense. This raises the question of intensity of sharpening (number of grinding passes) and length of intervals between sharpening. Different studies and suggestions for grinding knives were carried out in the past. But since then, the quality of knives' facing has improved greatly.

Many operators of forage harvesters have developed an intuitive understanding of the need for sharpening. But in recent years, machineoperators have not adapted their grinding strategies to required grinding intensity of modern high-quality tungsten-carbide-coated knives.

Therefore, this project includes surveys of operators about their knife grinding practices and clearance adjustment. Research shows there is great variability. Operators are grinding from 1-6 times per day. Also, the number of cycles per grinding operation has a wide spread. It

reaches from 1-10 and up to 40 cycles per grinding operation. Total number of grinding cycles per day shows a great variability, too. Many drivers grind more than 75 cycles per day.

When adjusting clearance, the variability is lower. About 75% of operators are adjusting immediately after grinding, almost 10%



Figure 2. Effect of sharpness and clearance on cutting energy.





carry out this task after every second grinding operation, while remaining operators do it 2-3 times between grinding operations.

Since survey data indicated that chopper operators sharpen frequently and intensely, operators using modern high quality knives might be advised to sharpen less frequently and with less grinding stone passes. Nevertheless, there is a certain number of chopper operators who know about the current conditions of their cutterhead, and grind knives in the right intensity.

According to survey results, many of the chopper operators can reduce the effort and cost of grinding and increase the life of their knives. Every driver has to develop their appropriate grinding strategy depending on the quality of their used knives and the prevailing operating conditions. This requires regular monitoring of the cutterhead. A look at the knives and a strip of the

thumb on the blade can give conclusions to the sharpness of knives. With this review, before grinding, the driver gradually gets a sense of how past conditions have affected the knife wear. By using this inspection after grinding the driver can draw conclusions about the effects of their grinding work and develop the right long-term grinding strategy.

It is critical to adjust the shearbar-to-knife clearance after every grinding procedure (and an additional 2-3 times/day) to ensure chopper is running optimally, diesel consumption is reduced and chopping quality is right.