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Retrieval and preparation of hedgerow cuttings and thinnings

Wall-hedges or hedgerows typify large areas of the Schleswig-Holstein landscape. The re-growth has to be regularly cut-back and the material therefore represents regenerative raw material. The technical task lies in sawing off the growth, the hedging, and the rational retrieval and preparation for further use of the very uneven material.

Fig. 1: Application of the chopper at the hedgerows

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The ecological value of hedgerows depends upon the fact that these growths typify the landscape, are generally regarded as regenerative raw material, and are CO_2 neutral. This means that with the burning of such material the same amount of CO_2 is released as is required for the growth and development of the plants involved.

Technology for hedge cutting

The hedge, originally planted as field boundaries, grows upon a wall and comprises a variety of wood plants. As a result, the technology must be capable of dealing with a wide variety of conditions.

To cope with these, the hedge shears mounted as an accessory on a backhoe tractor, the operation of which can be exactly controlled regarding height and distance by the backhoe operator, has proved itself. The hydraulically powered blades with an opening width of 750 mm (according to model) cut a number of stems simultaneously held by a gripper. The cut stems can then be laid down by the backhoe. It is said of this concept of shear cutting that it breaks the cut surface and allows it to shred.

As an alternative solution, a system used in forests operated from a processor head and with a drawing cut was tested. This has a shorter cut and the disadvantage thereof is compensated by the fact that this system can be repeatedly applied to the same spot. The thinnings are held by a pair of grippers directly above the blade during cutting. Following the cutting operation the cut stems are held by a further pair of grippers further up the stems so that the lower grips can be opened to take hold of further wood. In this way one stem after the other is collected into a bundle and then precisely laid down by the backhoe arm. In this way the amount won per working cycle can be increased (*table 1*). The depositing takes place with a view to the later pick-up of the material as a longitudinal swath parallel to the run of the hedgerow.

The characteristic operation of the processor head is reflected through longer cutting times and by the number of cuts per swivel operation. The speed and performance depends upon the capabilities of the operator and the nature of the hedgerow.

The costs for cutting the hedgerows depend upon its age and condition. Additionally, these factors are dependent upon regionally-based exceptional conditions. Thus a farmer or householder can pay between 1 and 3 DM/m for hedging.

Technology for picking-up the swath

The demanding requirement lies in the picking-up of the broad swath and consolidating the material. It is also feasible that the loader arm could deposit the cut bundles directly in the chopper. However, both operations have differing performance requirements and different susceptibilities to difficulties, so that they run better when separated from one another.

The swath dimension presents the starting point for the planning of the pick-up technique and the chopping equipment. Earlier measurements gave the breadth of the laid material as 3 m by a height of 1.8 m. In appropriate experiments the material was able to be reduced by the use of tensile belts down to a diameter of 0.5 m. Based on this, an intake with a 3 m wide pick-up was built. Other solutions have a narrow intake for larger cuttings.

A lateral restraint is aimed at consolidating the material and channelling it to the chopper drum. The conveyance floor comprises a number of rollers with conveying attachments. Thanks to the hydraulic powered system, the retrieval speed can be adjusted to suit the conditions. This should allow continuous pick-up and forward progress.

Experience from practical trials shows that the laid swath was considerably larger

Table 1: Measured values for the performance of shears and processor head

	Hedge shears	Processor head
Woodchip volume [m^3/10 m of hedgerow]	1,1	1,5
Cutting time per swivel operation [s]	17,1	23,7
Mass per swivel operation[kg]	20,0	24,3
Cuts per swivel operation	1	2,2
Speed [m/h]	60,1	45,8
Performance [m^3/h]	6,6	6,9
Performance [t/h]	2,4	2,5

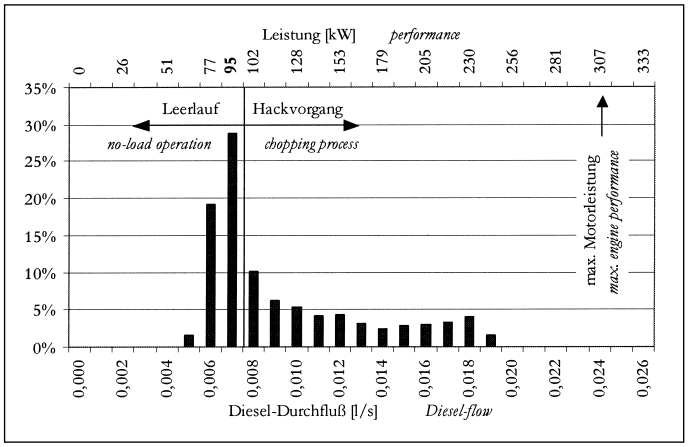

Fig. 2: Extent of utilization of the chopper system with regard to installed power

than that originally envisaged. This meant that contrary to the plans no steady forward progress was possible so that the built-on crane had to be used. A major reason for this lay in the fact that apparently there was more timber growing in the hedgerow than originally estimated with 1 m^3 per 10 m hedge.

Because of this, example swaths were once again measured, this time by another method. The cross sectional area of the swath was measured. From these volumes the built-on crane took grip-fulls out. In this way, a consolidation near to practical conditions was achieved. This lay in the ratio 1:11 to 1:19 and was only half as high as was estimated before. After that, it was possible to compress the awkward material into a cross sectional area of 0.7 m^2. The inlet of the chopper was adjusted to cope with this size: 1.5 m width and 0.5 m height. These dimensions seemed very large. For this reason the hedgerow shears or the processor head should lay a double swath where they are dealing with a strongly growing hedgerow with more than 1.5 m^3 woodchips per 10 m hedge length.

Technology for chopping the picked-up material

Drum choppers are more suitable than disc choppers for the high-throughput production of woodchips. The mechanical parts for the pick-up and the chopping of the material must be transported by a vehicle and powered by an engine.

Special demands are made on both, demands which can best be met by agriculturally-associated solutions. Alongside powering via tractor pto or via an auxiliary engine there is the possibility of utilising the drive system of an implement already established in agriculture.

The power requirement of the chopper is high, that of the drive system low. In order to be able to drive on the roads or on field surfaces, with or without trailer, on uneven surfaces or wet ground, high demands are required of the drive system. Furthermore, a continuous forward motion must be given even with slow working speeds. This can be achieved with hydrostatic drive.

A possibility of meeting these different types of demands in respect of performance, drive system and engine is offered by the self-propelled silage harvester. The idea of utilising such an existing system for other reasons is as old as the existence of these implements themselves.

For a long time now, such machines have been used on the hedgerows in Schleswig-Holstein, whereas predecessors of this type of rebuilt machine were in use substantially earlier in southern Germany. The difference and the innovation lies in the target of replacing with a continuous operation the sectional system used up until now.

The broad intake mechanism with pick-up and aggressive intake rollers retrieves the material and channels it to the drum. The built-on crane is envisaged here as support where individual stems lie the wrong way or where thicker stems have to be pulled-in. The inbuilt chopper drum has a breadth of 0.75 m and a diameter of 0.7 m determined from the mass of the consolidated swath. It is so dimensioned that the inner capacity of the silage harvester is completely filled.

Trunks measuring 0.4 m diameter represent the maximum size of material to be chopped.

In order to be able to give details of the uptake performance, different data were recorded and processed during the operation. Aim was to achieve a woodchip throughput of 80 m^3/h.

Determining the energy requirement for chopping

The energy required for chopping the thinnings and hedgecuttings was determined through measurement of fuel consumption. For this, a flow meter was integrated in the silage harvester fuel system. At the same time the fuel flow gave information on engine power and, with that, the extent to which the chopper capacity was being exploited.

The average energy input required for chopping was about 8 kWh/t of chips (n = 50, s = 1.6).

In comparison with the energy content of the woodchips of 9 MJ/kg at 45% moisture content, the required mechanical energy equalled only 0.3% of the energy released through thermal utilisation.

Exploitation of the chopper system

The target in using the chopper was to achieve continuous working operation, allowing maximum exploitation of available engine power. The measurements of diesel flow and engine power indicated to what extent this was being achieved. In *figure 2* the kW classes are recorded according to frequency during the chopping operation. These cover the empty-running of the system to 95 kW. At 50% of operational time, this occupied too high a proportion. The total engine power of 307 kW was not available because of the system safety switch to protect against overloading.

Moreover, there occurred a broad distribution of the classes with values under 5%. The peak of the used power was represented by a value of 256 kW. The broad spectrum of the kW classes showed that continuous feeding of the drum with enough material was not achieved. The material flow must be improved through attention paid to the way the wood lies in the swath as well to intake machinery operation.

Economic situation of woodchip production

Total chopping costs were 400 DM/h. This included 300 DM/h for the chopping system itself and 100 DM/h for the tractor with container system for transporting the woodchips. The costs may not, as is the case with hedging, have to be met by the owner of the hedge but instead should be covered through the sale of the woodchips.

The prices paid for the woodchips are strongly dependant on the regional market situation as well as the quality, i.e., moisture content and size distribution. The volume weight is applied as reference value. This however, can vary between 250 and 350 kg/m^3 increased, e.g., through the loading system in transport, or by the differing moisture contents.

This explains the price difference of from 7 to 27 DM/m^3. The transport to the heating station was costed at 5 DM/m^3. In reality, a heating station repaid the transport costs ex farm with 10 DM/m^3. This means that 40 m^3/h has to be produced on average per day. Taking into regard the empty-running time of 50% the chopper must therefore average 80 m^3/h with maximum throughput higher than this.

This sort of figure impresses how important it is to keep the machine filled continuously and working at capacity.