



Trends in feed harvesting technology

Innovations in Feed Harvesting: From Mowing to Baling, Efficiency and Precision Drive the Future of Forage Technology

By Heinz-Günter Gerighausen, Kürten

Homogeneous feed qualities directly impact the animals' milk and meat yield as well as the cost structure of the business segment. From mowing to harvesting, all developments are aimed at handling the harvested crop according to its intended use, high efficiency and increasingly relieving the drivers' workload. This includes larger working widths for mower implements as well as determining the dry matter content of the harvested crop during mowing and electric inclination adjustment of the rotary tedder from the tractor cab. The new short cutting method has become established in self-loading trailers, which is advantageous for a performance-based nutrient supply for ruminants. Increasing farm and herd sizes are continuing to necessitate efficient feed harvesting. The latest generation of forage harvesters is achieving new dimensions in performance, from the header to pre-compaction, the drum, the cracker and the accelerator, up to and including the 'chopping tower'. Increasingly, processors and transporters of post-harvest products also have comparable expectations of square balers. These have been redesigned – from the drive to the density control system and the knotter – which is good for trade, transport and especially the environment.

Mowing, tedding, swathing

Efficiency in feed harvesting starts with mowing. No matter whether a conditioner is used or not, the working widths of front/rear combinations are now over 14 m. Mower implements without conditioners are then sure to attract particular attention, because the mower consists of four cutter bars arranged in a line, with two cutter bars per side. The core element is the patented gearbox between the pair of cutter bars on each side, which fulfils four essential functions: it transfers power to the synchronised cutter bars running on one side, is part of the frame and assumes a load-bearing function. At the same time, the design of the gearbox enables independent movement between the bars on one side, because it acts as a connecting joint and permits lateral adjustment to the ground, comparable to that of a 3-metre machine. In the transport position, the gearbox, as a central element, enables compact folding with a

transport width of less than 3 m and a transport height of less than 4 m. Long-term experience is still lacking with respect to starting safety and wear behaviour at the joints in the light of significant load cycles.

A new supplier of self-propelled mowers with a working width of 10.50 m has also emerged on the market. The core elements of the new machine are the trailed, suspended mowers with integrated relief, all at a relatively low weight of 8.5 t.

Having information about the current growth conditions at the time of mowing is an advanced feature. It is not possible to predict wilting and therefore determine the time of harvesting using only the dry matter content. The feed mass per square metre, solar radiation intensity, wind speed and relative humidity are other significant parameters.

Every grassland farmer who produces preserved feed in the form of hay and silage uses a rotary tedder. A flatter rotor inclination is better for turning after tedding, when the crop is broadly distributed, because this increases the tines' contact area with the grass stubble and therefore enables more consistent pick-up, resulting in a more consistent dry matter content. Every manufacturer of rotary tedders offers an adjustment option. These are hardly ever used, even the tool-free adjustment options. The effort and time required appear to be too high. So the implement remains in its 'factory setting'. Remotely controlled operation from the cab then offers an innovative and convenient solution. From there, the user can centrally and synchronously adjust the spreading angle of all rotors infinitely between 13 and 19 degrees at the push of a button. This enables a consistent drying process to be controlled, particularly in the case of heterogeneous grassland growth. This solution is also pioneering: it enables automatic adjustment even in autonomous operation and contributes to ensuring the efficiency and quality of feed harvesting in the long term.

What are called belt pick-ups are used for picking up harvested material deposited in windrows with low loss and gentle handling when threshing grass seeds and other sensitive crops. This ensures the efficient collection of material with coarse stems. This concept is now also available in feed production as part of a continuous swather – an interesting developmental step that still has to uncompromisingly demonstrate its versatility under our operating conditions.

Self-loading trailers

Further manufacturers are responding to farmers' demands for a very short cut, because short cutting has been redefined for self-loading trailers. The standard is no longer a theoretical cutting length of 34 mm, but 22 to 25 mm, resulting in a cutting quality with a lower percentage of excessive lengths. This percentage of excessive lengths is also a determining factor when choosing a forage harvester or self-loading trailer because, with the same theoretical cutting length, the percentage of excessive lengths produced by a forage harvester is always lower. Nevertheless, there is also a market for self-loading

trailers or combination trailers. Self-loading trailers are operated mainly on distributed fields of a modest size. Essentially, wherever frequent field changes with longer transport journeys mean that the threshing time to operating time ratio can no longer be economically justified.

Balers

Round bales have proved their worth as a preservation alternative. The baler-wrapper combination offers the fastest preservation option. Just previously in the windrow and well cut by the cutter bar, the cut material immediately lands in the bale chamber. Whether variably or in the fixed chamber: after being compacted, the bale lands on the wrapper, which forms a virtually gas-tight fermentation chamber with the desired number of film wrappings, all of which is done not even three minutes after being picked up. Short cutting is now also possible with round bales. With 41 blades and a theoretical cutting length of 27 mm, this offers farms with small herd sizes an alternative to bunker silos. Particularly when the daily feeding rate is not sufficient to consistently prevent degassing and post-heating. Precise cutting and high compaction require power. This particularly applies in the case of round balers. The drives are then redesigned accordingly. They completely forgo chains for the rotor and main drive of the baling mechanism. Instead, gearboxes with overload protection of up to 5,000 Nm (approximately 250 kW) are used. This reduces wear, minimises maintenance effort and increases operating reliability. The machine therefore enables very high throughputs even with a full complement of blades. The combination of a new drive and an innovative cutting mechanism represents a new performance class. This system therefore clearly stands out from the current state of the art.

The slogan is well known and proven: 'The windrower makes the bale, the baler merely shapes it.' Nevertheless, there are more than enough practical situations in which the feed masses are insufficient for a uniform and wide windrow. Several driving options and strategies are then available for achieving a uniformly filled and compacted round bale. The results are continuously displayed on the baler's control panel. The driver remains the key element in producing a perfectly shaped bale. One relieving alternative is a technique in which the baler is guided to the windrow via a hydraulically controlled swivel drawbar so that the harvested material results in a correctly formed bale over the shortest possible distance from the pick-up to the bale chamber.

Mantle and wrapping film is used as standard for silage bales. The volume of film is determined by the number of wraps required on the bale. It is standard practice in this process for the film to be guided over the centre of the rotating bale with the same pre-stretch. In order to reduce the portion of film that overlaps extensively and frequently on the flat side, one manufacturer is offering the option of positioning the satellite slightly below the centre of the bale, resulting in a possible saving of at least 25% film. This relocation of the wrapping focus can lead to the occurrence of different film 'pre-tensions' at the edges. This leads to the question of whether the tight adherence of the film in these specific areas is then still ensured.

The market has geared up for striking and equally interesting parameters for big balers with a cross-section of 120 x 90 cm. Such a large bale should have a transportable length of 2.45 m and weigh at least 500 kg when filled with dry straw, corresponding to more than 200 kg/m³.

A completely newly developed machine concept combines high throughputs with consistently high bale densities. In practice, up to 70 tonnes/hour and consistent bale densities of over 200 kg/m³ are achieved. The machine concept is based on a main gearbox that enables a linear power flow and is integrated into the frame. This goes hand in hand with a slender drawbar and a short propeller shaft. Two flywheels rotating at 1,650 rpm that are arranged longitudinally to the direction of travel store a great deal of energy and stabilise the compaction process. They are positioned on the left and right sides of the machine respectively. These are switched on in succession on starting, followed by the piston and then the rotor. The technical effort required for 'starting' is therefore less than that of previous solutions. In the event of overloading, the flywheels are abruptly decoupled via an electrohydraulically activated multi-plate clutch and are therefore separated from the main drive. The piston is actively braked in this process. This system replaces shear bolts and cam clutches. The entire drive train consists of power bands and enclosed gearboxes. This significantly reduces the maintenance effort. Besides the drive propeller shaft, another shaft leading to the knotter mechanism also has to be maintained.

New assistance systems support and relieve the driver and the technology. The torques of the rotor and feed rake are continuously recorded. If the torque curve indicates that the feed rake might become overloaded, the system automatically shuts off the rotor and the feed rake shortly before overloading actually occurs. This extensively enables the number of failures to be reduced. The load data recorded via the sensors is additionally displayed on the ISOBUS terminal. The driver is therefore always provided with the latest information on the current operating rate status of the baler and can react accordingly. The TIM solution (TIM = Tractor Implement Management) so far familiar from round and square balers can also be used here. After entering the corresponding driving strategy, such as e.g. maximum throughput or high bale density, the system adjusts the driving speed depending on the machine load and material behaviour. The AI-based evaluations of the sensor values enable the optimum performance level to be maintained automatically, even with changing crop types or windrows.

Another AI-supported assistance system regulates the length and weight of the bale in synchronisation with the baling process according to individual specifications. This enables a very high level of bale weight and length homogeneity. The driver only has to set the length and weight; the system undertakes all other adjustments automatically. In addition, the algorithm uses an internal memory to continuously evolve. Regulation is therefore anticipatory rather than subsequently corrective. With weight deviations of only +/- 2%, this concept sets new standards in terms of quality and cost-effectiveness, and all without an integrated weighing device.

The McCormick and Deering principles are familiar in knotters. The McCormick loop knot is the strongest knot, whereas the Deering knot has proved to be the most secure knot. A double knot using the McCormick principle is new. It combines high knot strength with low yarn tension and consistently rules out yarn residues in the knotting process. This new knotter produces two loop knots during a binding process. 70% of the yarn's tensile strength are therefore retained. This is the same value as with the classic loop knot, but 20% better than with the typical Deering knot. This enables yarn with a higher running length per kilogramme to be used, or the number of knots per metre to be increased while maintaining the same bale stability – an economically and ecologically valuable development.

Forage harvesters

The global market for forage harvesters is exhibiting a clear trend: the requirements of farms with high harvest volumes and tight time slots on throughput, functional reliability, multi-crop suitability, operating comfort and cost-effectiveness are constantly increasing. Existing forage harvester concepts often encounter their limits due to bottlenecks in the material flow or assemblies that are not optimally coordinated in technical terms. And these technical requirements start with the headers. Whether for grass, GPS or maize harvesting, the technical design of the header extensively influences the performance potential. A crop-specific setting is possible via a separate drive train. This now also applies to the pre-compaction rollers, which intensively pre-compact the harvested material and feed it to the chopping drum at the desired speed and therefore for a suitable cutting length.

The key component in the new generation is the 910 mm material flow channel, which is currently the widest on the market. From the front attachments to the intake, the cutter drum, the corn cracker, the accelerator and the discharge chute, all assemblies have been redesigned and coordinated with one another for this width and throughput volume. The reason for this is that we are dealing with performance ranges of up to 500 t/h fresh material. The core element of this is a new flex drum, which enables various drum configurations (V20 to V36 blades). Only the ring segments and blades have to be exchanged for this. The familiar corn cracker has increased to a diameter of 310 mm with a working width of 750 mm. The discharge chute is also equipped with automatic vertical damping to ensure that the harvested material lands in the transport vehicle, not next to it.

Numerous innovations have been developed to monitor the sharpness of the blades, but none of these have made it past the trial stage. The new reluctance sensors, which are located above the material channel, record the status of the complete blade over its entire width. In practical operation, the driver defines the desired sharpness and the related grinding strategy. The system then outputs a message to the driver if necessary.

Grain breakdown (CSPS value; Corn Silage Processing Score) is an important quality criterion when harvesting silage maize for biogas plants and cattle farmers. A value of over 70% is regarded as very

good. The degree of quality achieved during harvesting can be determined retrospectively either via an app or by means of a laboratory sample, whereby the latter takes more time. More recent developments determine grain breakdown by means of image analysis – a milestone in real-time quality analysis that can also be used to always adjust the cracker's gap size to the current harvesting conditions. Field-specific documentation offers the option of adaptation to future cultivation and variety strategies.

Smart harvesting-

Networked machines enable the clear organisation and calculation of feed harvesting, from processes to cost structures and quality influences. The working platform for the entire harvesting operation is a newly developed app that organises the harvesting process based on the logic of a WhatsApp group. This is an interesting and exciting development that requires personal commitment.

Summary

Harvesting technology is increasingly being oriented towards needs-based precision so that animals can consume even more nutrients and therefore be fed in a more performance-friendly manner, and in a way that also reduces the workload of operators and livestock farmers while giving consideration to ecology and sustainability, thus making technical progress meaningful and enjoyable.

Media Contact

Media contact:

Malene Conlong

Tel: +49 6924788237

Email: M.conlong@dlg.org

About DLG

With more than 31,000 members, DLG is a politically independent and non-profit organisation. DLG draws on an international network of some 3,000 food and agricultural experts. DLG operates with subsidiaries in 10 countries and also organizes over 30 regional agricultural and livestock exhibitions worldwide. DLG's leading international exhibitions, EuroTier for livestock farming and Agritechnica for agricultural machinery, which are held every two years in Hanover, Germany, provide international impetus for the local trade fairs. Headquartered in Frankfurt, Germany, DLG conducts practical trials and tests to keep its members informed of the latest

developments. DLG's sites include DLG's International Crop Production Centre, a 600-hectare test site in Bernburg-Strenzfeld, Germany and the DLG Test Centre, Europe's largest agricultural machinery test centre for Technology and Farm Inputs, located in Gross-Umstadt, Germany. DLG bridges the gap between theory and practice, as evidenced by more than 40 working groups of farmers, academics, agricultural equipment companies and organisations that continually compare advances in knowledge in specific areas such as irrigation and precision farming.

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