Waldemar Gruber, Bonn

Trends in Sugar Beet Harvesting Technology

In this contribution, important trends in sugar beet harvesting are presented, such as those which will manifest themselves in the machinery- and implement programme shown at the Agritechnica 2003. This preview only provides pre-information and cannot replace a trade fair visit. Completeness is not aimed for.

Structural change in the sugar industry is continuing. Sugar factory shutdowns result in longer campaigns. Since at the same time transport distances are growing, beet is stored at the field's edge in virtually all areas. This in particular requires efficient harvesting and loading systems. Especially in the last campaign weeks, weather-related risks due to wetness, frost, and snow are increasing. An important prerequisite for the efficient care and protection of clamps at the field's edge is high lifting quality with the focus on gentle beet treatment in the harvester. For the sake of greater efficiency, developments towards 8- and 9-row self-propelled tankers can be discerned.

Harvesting Systems

In Europe, self-propelled sugar beet harvesters are dominating the market. While in Germany almost 75% of the sugar beet area is harvested by 6-row self-propelled tankers, 6-row lifter-loaders account for a similarly large percentage of the sugar beet harvest in France. The wider use of tankers in Germany is a result of the smaller average field size. In the classic French sugar beet regions, field lengths often exceed 500 to 600 m. There, the beet is often transported to concrete clamps, where it is put in intermediate storage. In Germany, the beet is generally stored directly at the edge of the harvested lot.

Dr. Waldemar Gruber works as a counsellor with the Rhineland Chamber of Agriculture in Bonn and compiled the present overview on behalf of the DLG.

Keywords

Trends of development, sugar beet harvesting, topping and lifting, cleaning, loading

Defoliating- and Lifting Units

Mainly flail choppers are used for defoliating. In these units, the beet leaves are removed by sucking flail shafts. Subsequently, flat-leaf screws feed them into a spreading unit for distribution. The hydraulic drive of the centrifugal leaf spreader allows the throw to be steplessly adjusted. In many machines, the height of the defoliating tools is set by sensing wheels. The machinery manufacturers are offering leaf discharge on both sides more and more, which allows for easy two-way lifting on the field. In addition, the leaves are evenly distributed over the entire field area. So-called integral choppers, which are increasingly gaining in importance, have been on the market for quite some time. Some manufacturers offer them as an option, and the product range of one manufacturer exclusively comprises integral choppers. The chopped leaves are deposited between the rows. The advantage of this design is the even distribution of the intensively chopped leaves and the light construction of the chopper type. These units generally also use sensing wheels for depth guidance. Contactless depth measurement with the aid of distance sensors is employed as well. Generally, the after-topping knives are guided parallel, and automatic cut size control provides precise topping while keeping harvesting losses to a minimum. In high-standing sugar beet, which has already been flailed off more, topping cut size is reduced, while it is larger in deep-sitting beet, which cannot be cleanly flailed. Modern machines enable the cut size to be adjusted from the driver's seat. Driven polder shares as block swingers or phase-shifted alternating swingers are almost exclusively used as lifting tools. At the Agritechnica, a lifter will be shown whose disc tools are actively driven by hydraulic motors and feature a pendulum link instead of the usual fixed link. Due to a 60 mm long pendulum path, the position of the wheel lifting shares is determined by the row. The current deflection of the shares can be used to control the autopilot.

Cleaning Equipment in the Harvester

After the beet has been lifted from the soil, one already tries to reduce the quantity of attached dirt by integrating tools into the lifting share. Lifting rollers behind the lifting shares extend the cleaning path and transport the beet from the lifting unit to the cleaning equipment. For heavy soil conditions, some machines are equipped with counterrotating rollers, whose direction of rotation is opposed to that of the other lifting rollers. This allows dirt separation in the lifting unit to be improved. In the cleaning steps between the axles, the manufacturers use different cleaning elements. Turbines are the most widely employed tool. Sifting belts, knob wheels, and cleaning drums or axial cleaning rollers with adjustable direction of rotation are used as well. Sifting belts are usually tensioned hydraulically. Many harvesters feature stepless belt velocity adjustment from the driver's seat and a reversing system. The rotational speed of the turbines can also be steplessly adjusted from the driver's seat. In many self-propelled machines, the setting of the cleaning equipment is adjusted at the terminal. More and more modern machines are equipped with self-controlling power split. If the harvester needs more power for propulsion under adverse soil conditions and if the oil pressure is not sufficient to drive the turbines, the system automatically reduces the driving speed in order to guarantee reliable beet lifting and cleaning. From the turbines, the beet is generally conveyed into the hopper by elevator belts. The rotational speed of the elevator belts should be kept low in order to protect the beet. In the elevator, hopper augers distribute the beet evenly. The chassis design of a manufacturer, which features rubber tracks mounted on the front axle, pro-

Fig. 1: Innovative beet harvester from Grimme: the Maxtron 620

vides cleaning over the entire machine width of 2.80 m. In this machine concept, the beet flow is no longer narrowed by small distances between the wheels (*fig. 1*). It can be expected that this design enables damage to the beet to be reduced and the cleaning effect to be improved. The hopper is generally emptied using an unloading belt.

Cab, Electronic Support, and Management Systems

The harvester cabs are generally well insulated against vibrations and noise in order to guarantee good working conditions for the driver even on long work days. Strongly inclined edges in the front are intended to provide an optimal view of the lifting units while allowing the driver to maintain a comfortable body position. The most important functions of the harvester can be operated with the aid of an ergonomically positioned joystick. Important data regarding the operating status of the machine are shown visually. In order to allow the driver to react to malfunctions quickly enough, visual and audible alarms indicate critical operating values.

More and more modern sugar beet harvesters and cleaner loaders are equipped with electronic display-, monitoring-, and control systems. These systems help the driver to find optimal machine settings. Belt- or turbine velocity, for example, can be steplessly controlled and adapted to changing work conditions. Cameras monitor the depth guidance of collection tables and the boom control for the setting of low falling heights.

Terminals which can be operated intuitively are a novelty. A so-called colour touch screen terminal allows the driver to control the machine with the aid of pictograms. Using a cross section of the harvester, the machine operator touches the area which he wants to control or adjust. This improves operating comfort significantly while reducing training requirements for drivers.

In addition, control systems for machine functions are offered which open up the possibility of remote monitoring through remote service. Since many machines are already equipped with control units which receive all functional data of the machine, such remote monitoring systems can be realized. The information pool of the on-board computer comprises parameters such as the filling level of the fuel tank, the currently selected gear, the temperature of the hydraulic oil, and the position of the rear axle. Thus, malfunctions of the hydraulic system or mechanical defects can be located more easily. Via mobile phone and PC, the available data can also be transmitted to a control centre, which organizes the timely supply of operating resources, for example. If malfunctions occur, customer service can also read out data through remote inquiry and localize defects with the aid of remote diagnosis. Often, the drivers can be instructed via telephone to fix problems themselves. The radio network also enables the work quality of the machines to be monitored. In addition, instructions for the optimization of settings can be transmitted to the driver if required.

The data stored in the on-board computer are also used for cost calculation. In addition to the harvested area, travelling-, harvesting-, unloading, and standing times as well as the distances covered during the ride to the field and during work on the field can be documented. For juster cost calculation, the distance covered on the field is of great interest. Long rides to the field edge clamp, however, are unproductive for the harvest and can increase average harvest costs significantly.

Cleaner Loaders

Europe-wide, 70 to 100% of the sugar beet is put in intermediate storage on the field. At the beginning of the campaign, storage duration is three to four days. By the end of the campaign, it reaches up to 7 weeks depending on the region. In the factories, sugar beet is stored for no more than one weekend. In Germany, the percentage of beet pre-cleaned with the aid of cleaner loaders has increased to more than 90%. In recent years, a significant improvement of dirt separation has been recorded. Known cleaner loaders collect the beet from clamps over a width of up to 8.70 m and clean it using spiral rollers both in the collection area and on the following sifting belts. Grab arm loaders, which are part of the cleaner loaders, allow collection width to be extended to clamp widths of up to 14 m. The installation of clamp dividers enables the working width of self-loading cleaner loaders to be increased to 15 m. The loading reach of these machines must also be extended to 18 m by installing additional transport belts. The cleaner loaders are generally equipped with reversing systems. They prevent a standstill of the machine in beet clamps containing stones. In addition, load measuring systems are installed as optional equipment.

Soil-Protecting Chassis

The manufacturers of harvesters and cleaner loaders use the largest available tyre dimensions offered by the tyre producers. For harvesters, most manufacturers employ special chassis concepts featuring up to three axles, which provide the possibility of track offset. Recently, machines with four axles have been offered in order to enlarge the contact patch of the tyres which carries the load of the vehicle. Both French and German manufacturers equip their self-propelled machines with tracks. In these machines, the front- or the rear axle features rubber tracks. Twin tracks are also used to distribute the load of the vehicle over the largest possible area.