



Trends in sugar beet harvesting

Sugar beet harvesting advances with automation, soil protection, and digital logistics for cleaner, more efficient and competitive production

By Dr Klaus Ziegler, Eibelstadt; Christoph Ott, Eibelstadt; Dr Oliver Schmittmann, Bonn, Germany.

113 countries around the world produce sugar – 42 of them from sugar beet; these are primarily countries with moderate climates such as those in Western, Central and Eastern Europe, the United States, China and Japan. Around five million hectares of sugar beet are harvested globally.

Bioethanol production, which necessitates additional cultivation areas for sugar beet, is often coupled to sugar production. Not only since the emergence of discussion surrounding the 'energy revolution', this has been joined by a further development, particularly in Germany, i.e. the fact that sugar beets are used in biogas plants to break up maize-heavy substrate compositions. An essential role is played here by the finding that the sugar beet has one of the highest dry substance yields of any crop in an easily fermentable form.

Sugar companies and sugar beet producers in the EU had geared up for liberalisation as of 2017. After five years under liberalised market conditions, however, it has become increasingly apparent that conscious production for the global market cannot be achieved profitably (without state subsidies). Competitiveness is also linked to the cost-optimised capacity utilisation of the existing systems, resulting in the implementation of restructuring measures with factory closures.

Even prior to the war in Ukraine, poor harvests due to weather conditions and yellowing calamities, or currently infestation with reed glass-winged cicadas (carrying diseases such as stolbur and/or SBR = Syndrome Basses Richesses = low sugar content syndrome), actually led to reductions in acreage, lower sugar production, market shortages and consequently to rising sugar and beet prices, which are compounded by the sharp rises in (energy) costs for cultivation and processing at the same time.

Despite all of this, the 'cultivation boom' seen over the past decade, with increased demand for reliable harvesting technology, appears to have been superseded by a 'status quo' phase for the past two years: replacement and renewal of used machines.

The basic principle of 'harvesting what has grown' continues to apply!

It should be possible to harvest the sugar that has grown on the field and can be extracted profitably in the factories as completely as possible and store it on the clamps – as far as is feasible climatically and in 'phytosanitary' terms. The expert finding that the beet head now has a significantly smaller leaf base and contains fewer harmful non-sugar substances – due to breeding and cultivation progress – with the result that it can also be used for efficient sugar extraction is additionally coming into play. A technical response to the rapid development of beet yields in cultivation is also required: ever-increasing volumes are having to be transported away from the fields.

These relationships are unavoidably impacting the requirements of harvesting technology: gentle on the soil, low-loss, as little damage and as few (cutting) injuries as possible, no (green) leaf residues, easy – optimally comfortably and automated – to operate and nevertheless remaining cost-efficient and reliable.

6- to 8-/9- to 12-row

A certain plateau appears to have been reached in the beet harvesting segment in the general trend towards performance- and cost-oriented, fully automated mechanisation in agriculture. Large self-propelled machines, usually with six rows, increasingly frequently with nine rows and even 12 rows, and with (intermediate) bunkering are now the standard worldwide. What started back in 1974/1975 with the first 6-row beet harvesters with bunkers, the 'Südzucker-Betaking 3000' and the 'Holmer-System Paintner', has been, and continues to be, further perfected over the last few decades. Since then, no clear trend has been apparent in terms of optimum row spacings or growing spaces. Whether 30, 45, 50, 56 or 60 cm is the best row spacing depends on a number of other factors in the agricultural enterprise. However, a harvesting system must be capable of properly and cleanly harvesting 100,000 plants per hectare and transporting them carefully from the field.

Further developments in the areas of low-injury handling of the sugar beet and a low soil content with nevertheless low harvest losses – all with maximum soil protection – are now usually found only in the multi-row, self-propelled machines which complete harvesting with a single operator. 12-row versions always necessitate additional, sophisticated removal technology/logistics on the field. However, focus is always placed on reducing soil loads. Hauled 6-/8- and 12-row variants (topper + harvester-loader) have only survived on the extensive plains of North America and in the black earth regions of Eastern Europe, in which maximum efficiency in the shortest space of time is crucial – because of short harvesting

periods due to the weather conditions – and the transport width on the road is not subject to any special regulations. The prerequisite for this is extensively standardised operating conditions (large, absolutely flat areas; uniform, humic, sandy-loamy soils, etc.). Local differences in slope gradients, soil types and area structures quickly bring these simply designed machines to their limits in terms of losses.

Driver assistance systems

Changing demands on the external quality of the beets (scalping/whole beet) for biogas use and long-term storage are also driving innovations. High mobility, manoeuvrability, fast operational readiness and operating reliability are parameters for efficient operation on plots of all sizes (with/without slope). Great attention must be paid to ergonomic operation and training the operating personnel in comfortable high-tech driver's cabs.

Camera monitoring, including for entire machine assemblies, and touch screen operation via or on monitor interfaces demand maximum attention from the driver, who is thankful for any and all automation – driver assistance systems remain the major trend. However, this must not negate basic knowledge of the soil and harvested crop, i.e. keeping sight of top quality work with acceptable soil conditions. Projects to offer assistance for navigability and the optimum deployment time for the large machines have also been tested. In order to simplify the highly complex harvesting process, particularly when more than six rows are involved, machine manufacturers are investing a great deal of cash and manpower in the development of driver assistance systems, performance-dependent automation and the appropriate sensors required for this – often across companies in cooperation with scientists (e.g. adaptation of the vehicle's speed depending on the operating rate of the lifting and cleaning units).

Use of the latest chassis technology with balance and roll stabilisation for 2- and a growing number of 3-axle machines is not only increasing operating flexibility on sloping terrain. This is also the objective of extended, folding bunker booms for constructing larger clamps for 10-metre loaders or a digging unit on which the lifting tools (vibration shares and Oppel wheels) are mounted individually and adapt automatically, precisely and independently of one another to the (uneven) surface of the soil. This capability is likely to be increasingly appreciated, particularly for larger working widths, whilst it is a must for 12 rows. With regard to the weight, lighter but simultaneously robust materials are increasingly being used, and heavy skids or sensor wheels are being replaced with 'light' sensors. Machines for professionals can not only be (remotely) maintained with the aid of smartphones and/or tablet PCs; their settings can also be optimised (telematics), thus reducing working time and costs and making driving even better.

Minimum scalping or defoliation

The common practice in the USA of sugar beet defoliation/topping using shafts with rubber and steel flails, whose rotational speed and working height have to be individually adapted to the crop, has also led to the further development of scalping work with the skid contact sensor. At the same time, all

manufacturers are providing an efficient and inexpensive response to defoliation with solutions for what is referred to as 'minimum scalping'.

Topping and minimum scalping methods have quickly been accepted by farmers, as they equate to mass yields that are 3 to 4% higher. In the majority of countries/companies, the sugar industry's negotiating partners have agreed on specifying a 'target beet without leaves' – the technology has the appropriate answer.

Defoliation with two independently operating, front-mounted flail shafts is a fully-fledged alternative on the self-propelled beet harvester with bunker both for beets for biogas use and in the sugar factory. The hauled, 3-shaft defoliator with/without scalper is sold or operated in two-phase systems (e.g. overseas/in Eastern Europe). It must be possible to operate this, even in the 12-row version, at the same speed as the separately hauled harvester-loader.

Beet soil cleaning logistics

Efficient beet processing in the sugar factories (or biogas plants) necessitates the management of vast flows of goods. With campaign lengths of 120 days and more, the beet clamps have to be loaded around the clock. A key role in this is played by the (self-propelled) 'Maus' cleaning loader. All manufacturers have completed the move to a '10 metre intake width' – with the patented difference of the flexible working angle of the pick-up table.

Wider, higher clamps necessitate the adaptation of the harvesting technology (but also the intake technology on the cleaning loaders) as well as the logistics chains, which are supported and networked with diverse software programs. One hurdle is always operating under difficult, moist conditions with high percentages of wet, sticky soil in the clamps. The majority of manufacturers have shifted towards having seven (instead of six) rollers work in the intake downstream of the lifting assembly, equating to 15% more cleaning area. At any rate, the following is true in the dispute amongst experts regarding the advantageousness of turbine and/or roller cleaning: it depends on the setting! Turbine technology appears to be setting the tone amongst harvester manufacturers as regards flexibility, weight, fuel and cost reduction. Conversely, roller intake and cleaning forms part of the standard equipment for the 'Maus' manufacturers.

Stationary loaders are now only available for special usages (with a picking table for large clamps) – hardly any further development is now being undertaken here.

Clean and free of stones

For suppliers of sugar beets to a sugar factory, harvesting is completed with pre-cleaning and the evaluation of the exterior quality (primarily of soil/foreign object/leaf components). The situation is

different in/for biogas plants: dry or wet cleaning and, above all, stone removal are required depending on location and soil type. With growing interest from operators of biogas plants, an increasing number of established machine manufacturers are offering technical solutions for preparing these (sugar) beets accordingly. The potential procedure is determined by the method of long-term preservation of the beet material. Here, whole beet silage has become established due to reasons of loss and cost minimisation. Innovative, compact machines – in stationary or mobile operation – make use of the mechanical and physical properties of the sugar beets, such as their static buoyancy in water, for instance; beet washing can be carried out at the end of this process, but does not have to be.

Telemetry – electronics – performance

The development of technology for sugar beet harvesting and transport is characterised by the extensive use of electronics for regulation and control functions – be it in the sugar factory or up to the fermenter in a biogas plant. The touch screen technology is aimed at relieving the machine operator even further; operations are being increasingly automated in order to maintain or increase the quality of work and set-up times with changing drivers in 24-hour operation. Manufacturers are able to offer an entire package of networking: harvesting management, to-the-second video documentation of the entire work process or transport logistics with the sugar factory/biogas plant. The transport plan triggers the harvesting job for the harvesting community or contractor – in Germany, the majority of land is harvested on a cross-farm basis. On completion of the work, this in turn forms the basis for subsequent mechanised clamp uncovering and removal – and without manual intervention up to and including the provision of data relevant for invoicing.

Stricter exhaust emission regulations in the EU (exhaust emission standard Euro V is specified) are necessitating new engine technology (with the addition of AdBlue) without any loss of power output, but this is not 'needed' when selling to countries in the East. Automotive work with increasingly lower engine speeds is reducing fuel consumption and the volume level with ever more high-performance machines.

Soil protection is a must

The self-propelled beet harvester with bunker – usually with six and nine rows, also often with 12 rows – is setting the standard worldwide. In combination with the latest tyre technology, offset track driving in 3- or 2-axle machines ensures efficient, soil-protecting harvesting and creates a 'breathing space' in operation for periods of poor weather in the autumn. Progress in tyre technology (with the reduction of the tyre inflation pressure to 1.4 bar and thus an increase in the contact surface) primarily benefits the soil. Directional stability, lateral slope suitability and axle weight distribution have been improved in combination with sophisticated (hydraulic) suspension concepts. Simple, hauled 6-/8-/12-row harvesting systems (with separate defoliation) that are designed exclusively for efficiency and cost minimisation now only survive on the vast plains of Russia and North America. Hauled transfer vehicles with e.g. soil-protecting track running gear are now also used with beet harvesters with bunkers for intermediate

transport on the field wherever extensive field lengths and high yields necessitate this. The variety of suppliers in the (field) transport segment has increased significantly.

Conclusion and outlook

Cleaning and loading using a 'Maus' play a key role in the logistics networked with the organisation of beet harvesting. In countries with pre-cleaning at the edge of the field, the self-propelled 'Maus' cleaner loader with 10 m intake is now part of the standard procedure. In states with large collective clamps in the area (e.g. in France) the roller intake is replaced by a bunker that is loaded using a wheel loader/excavator. Smaller hauled or trailed machine variants are now only being developed for special solutions (particularly stones!). The mechanisation of clamp care, especially on a non-woven cloth basis, has become established everywhere in the light of long campaigns. Digital networking of sowing, cultivation, harvesting, clamp care and transport is ensuring the optimisation of the entire process chain. At the same time, everything is becoming more digital in increasingly high-performance on-board electronics with the linking of harvesting process monitoring and subsequent beet transport logistics. As additional key factors in the operating quality and performance of the harvesting machine, the machine operator's comfort and workplace are not being overlooked either.

Telemetry support and integrated weighing systems are optimising the process chain up to the further processing of the sugar beet, serve to ensure monitoring and provide assistance in maintenance and service. The soil content nevertheless remains the unknown variable in the harvested crop. All manufacturers are working on detailed improvements focusing above all on lower vehicle weights with a longer wearing part service life and ultimately cost savings. The competitiveness of beets – for use in sugar factories or biogas plants – is being stabilised and increased thanks to technical innovations; regarded globally, this remains necessary. The remaining machine manufacturers are now active in all important beet growing regions around the globe. Following cost-intensive development for the sensor-controlled automation of lifting tools (e.g. depending on the lifting speed) in order to relieve the driver, initial project results involving independent research institutions have been launched onto the market over the past two years.

The message for the good beet growing regions around the world remains that the latest, reliable technology on the field (with optimally trained drivers) significantly increases the competitiveness of beets and sugar!

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.

www.dlg.org