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Measuring yield during beet harvest

Because of its yield level, sugar beet sets high demands on production technology. Production is very closely linked to processing: the factory expects high sugar content, a low level of damaging residues and limited tare as well as punctual delivery. The haulage contractor requires logistic information over tonnage and location of heaps. The close association between beet growth and soil fertility means that data on yield increases the information required for spatially-specific systems and offers more information on rotation effects.

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Keywords

Sugar beet harvest, yield recording, recording system

There are different concepts available for continuous recording of harvested beet, although none are in practical use so far.

Precision is required in recording the comparatively small amount of beet on a spatial site. For 3 m working width, average intake is 20 kg/s, the spatial yield from 30 m of drill, 600 kg.

With these yields, tare of a weighing system must be limited. Thus weighing the bunker cannot be considered. More interesting are concepts which record the beet directly, several of which are in development.

Weighing rollers carrying the elevator webbing and measuring the beet there on is another concept but in modern harvesters the front elevator is short and the sieve stars transport a large proportion in the vicinity of the track curve upwards *(fig. 1)*. This system was developed in the USA and England and tested by Landtechnik Weihenstephan. It is installed in a Grimme potato harvester.

Own-thinking here is the installation of a belt weighing system beneath the – horizontal – transport webbing, or to measure impact energy at the elevator discharge point. Such a weighing system (e.g. in place of the guide baffle in *fig. 1)* takes up space and therefore reduces the bunker capacity.

Another way of directly measuring beet yield involves measurement of volume, or of individual beets. Mechanical probes (TSI) or laser scanners (Landtechnik Bonn) record the volume of beet on the elevator. This recorded value must correlate sufficiently precisely with the beet mass. The volume-unit measurement runs on a similar principle, the number and diameter of the beet being recorded at the header.

Calibration is critical with such a system. Certainly, beet diameter and weight correlate, as does volume of loose beet in the elevator. However the resultant values show a strong scatter. The scatter can certainly be specific for spatial areas when, e.g., soil or available water influence beet shape. There's also the advantage that calibration can be based on the pure beet without tare.

An alternative is the concept of measuring the beet within the harvest flow on the transport system. For this, the ring elevator is set as a unit on weighing elements. The more beet transported, the higher the measurement value. This solution was presented by Kleine at the 1999 Agritechnica. Detrimental is the high unit weight and the dynamic oscillations when in operation.

From this resulted the individual way for

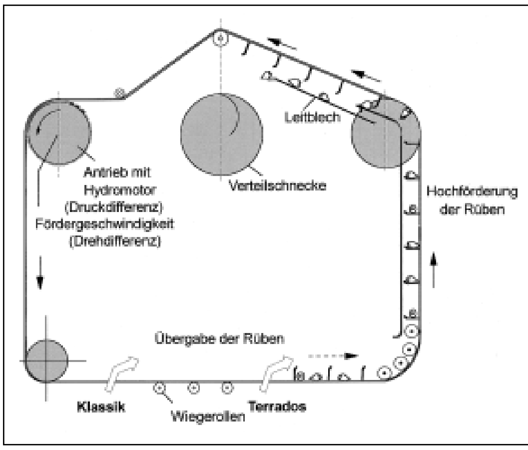

Fig. 1:The yield recording system measures the power demand at the elevator hydraulic drive

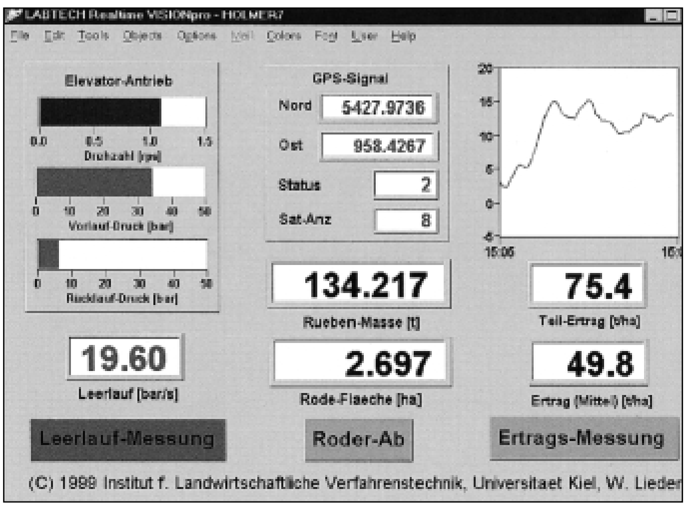

Fig. 2:The display shows all necessary information

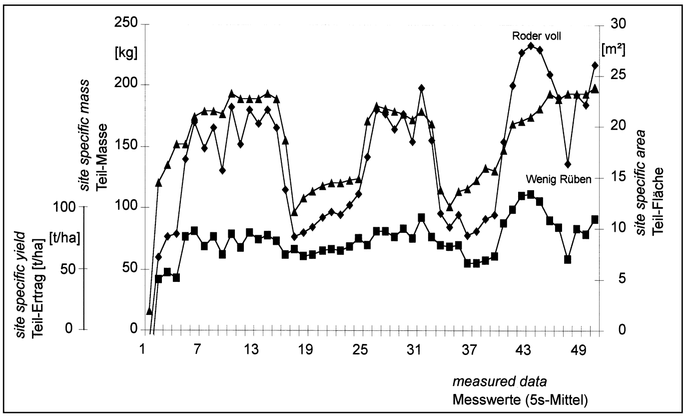

Fig. 3:Area yield and spatial areas at varied speeds.

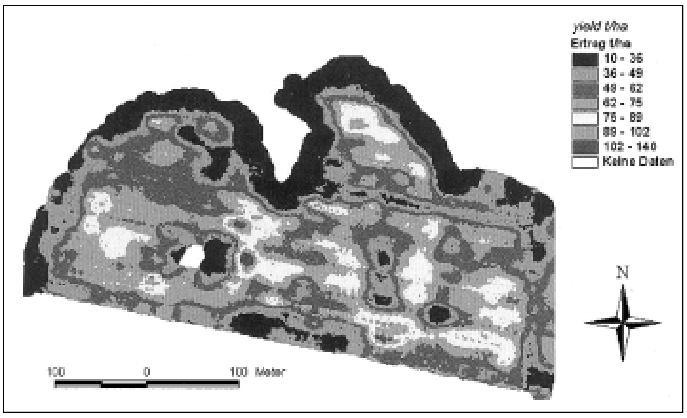

Fig. 4: Beet field yield map (with tare; 12.11.1999). Average 56t/ha, s= 24

measuring the mass of the harvested beets as they are transported up into the bunker. Measured in this case is the force in the elevator track curve rollers or the drive performance of the transporter measured as pressure difference in the hydraulic motor *(fig. 1)*.

Experience with the new recording system

Function

The recording system is based on the power difference between elevator drive under load or empty, recorded from the measured pressure difference and (variable) revolution frequency of the elevator. The measurement interval is 5s.The directional sensor of the harvester helps record area covered. The calibration factor is calculated from these values and the beet mass. The factor is given as a fixed value but was also, as with other weighing systems, monitored by test weighings.

Position data came via GPS with the antennae mounted on the cab roof. Data recording and storing was automatically controlled from the harvester Ab-signal. The harvested area data was slowed down to match the transport time of beet from lifting unit to elevator, i.e. about 10 s.

All important data is displayed in the cab *(fig. 2)*. A glance at the progress of the curve indicates if the system functions. Empty-running power can be altered via harvester controls. As this represents about half total performance, this is precisely calibrated. At the beginning of work with cold oil in the hydraulic system values are other than those recorded during continuous operation. Dry ground with ensuing dust creates different conditions compared with when the going is wet and for this reason the program offers the possibility of monitoring performance during empty-running on the headland and, if necessary, of making adjustments.

Results

The system proved itself during practical operations with a contractor. Recording error for a bunker-full to the transport system weigher lay by a few percentage points so long as the operator carried out the empty-running and zero-adjustment correctly and the bunker was not overfilled.

Recorded values on the transport weigher were recorded from the beginning of the test phase onwards. Due to the weather conditions during the first season in 1998 only a few measurements were carried out. But many yield maps were produced in the following season.

To test the sensitivity of the measurement system the speed of the harvester was altered *(fig. 3)*. The curve progression indicated the reaction of the system, especially the parallelism in the spatial areas. At the end of the presentation the curve showed a yield that was too high, caused by an overfilled bunker. When the filling height is exceeded the specially-fitted baffle is no longer effective. More important, the elevator is under more load because of the height of the beet pile and this puts more demand on the power drive.

The variations from the short recorded lengths with 3 m working width were balanced-out through interpretation over 30 m by the yield map program.

Further trials are planned for next season in which the number of harvested rows in a pass will be altered and, with that, the throughflow and filling degree of the elevator. All possible influencing factors are to be defined and considered in the system.

The recording system was fitted into a Holmer harvester for future spatial site-specific yield recording. The example in *figure 4* shows the large range up to 900 dt/ha. Competition for light and water at field edge, by woodlands or hedgerows reduced yield to 200 dt/ha at the factory, additionally reduced through the higher tare deduction. Does, therefore, the outlay in seed, plant protection and fertiliser pay in such an area? Or would field margin strips offer an alternative?

Tare

Tare belongs to the beet harvest. So far, there's no automatic recording of the proportion of soil and tops. At least the soil tare would be of importance in yield recording. This would vary per spatial area according to soil type, although there are no measurements so far. However this lack is tolerable: with a range of 10 to 16% the variation for spatial areas would be 3%.

The regulating of sieve star rpm can be taken as a first step against an increased soil tare. The revolutionary power is measured and if this rises significantly the sieve star reacts to the higher mass of soil and beet with increased rpm. Thus can the soil tare be reduced to an average value.

Summary

A new yield measuring system which records the beet mass via the drive power of the elevator has been tested as prototype in practical conditions. The results promise the delivery of further information.

The farmer can adjust for spatially-specific systems with technology and growing system, the contractor can better exploit the efficiency of his harvester operation. The beet haulier learns the exact position and tonnage of beet heaps and thus can better organise his truck fleet. The factory learns in the future very up to date information on harvested amount and yield growth in order to be able to plan the campaign accurately for full exploitation of the plant.