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Yield Mapping in Sugar Beet Harvesting

Yield mapping - well known in combine harvesting for a long time - provides information about the yield of the part field as well as information on the beet lifting capacity and on logistics for beet harvesting. The experiences with the system developed at the Institute of Agricultural Engineering in Kiel, Germany are presented in the following.

Yield mapping in grain-combines has been existing for decades and is starting to become a common practice in combination with site-specific farming and big combines.

Yield mapping in sugar-beet production is interesting for several reasons. Sugar beets are a pretentious crop and thus should especially well demonstrate the heterogeneity in the yield-potential of soils. Furthermore, the records offer basics to the process-manager for analysing the lifting-rate and for harmonising the transport from the field, the logistics, and the planning of the harvesting season.

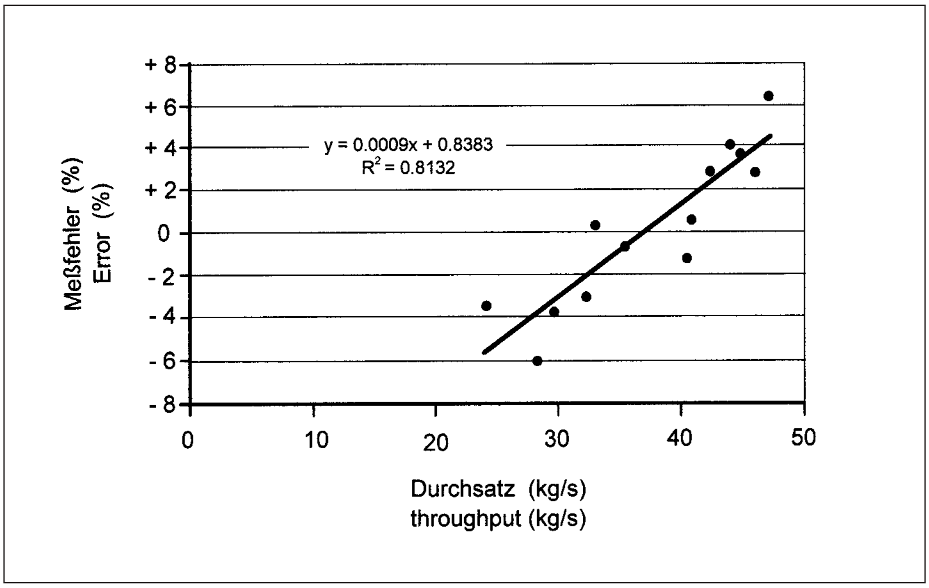

Fig.1: Influence of throughput on the difference between measured and true mass

Several system-concepts are in a developmental stage. They are based on the principle of weighing a belt-conveyor or on recording of beet-numbers as well as beet-diameters. The Kiel-concept (see also Landtechnik 2001, No. 4) uses the power needed for the chain-conveyor, which is charged by beets coming from the rotating-star-sieve and transports them upwards into the bunker. This concept can be realised with small changes in the driving system of the machine. It has been used for several harvesting-seasons, and thus it seems appropriate to report about results with the technical-concept as well as with yields.

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Measuring technique

The target figure throughput-rate (kg/s) is attained via the power needed for the drive. This power again is recorded via the pressure (bar) in the hydraulic hose and sensed by means of a pressure-transducer. Generally, the power for the drive 1 increases in proportion to the mass, but in actual use additional factor resulting from the power needed for the idle conveyor as well as from high filing levels within the vertical transporting are effective. This will be outlined in detail.

If the filling-level of the bunker is too high, the conveyor-chain scrapes along the beets lying on top. This increases the power for the drive, and should be avoided. High conveying-rates can result in more than proportional increases of the record-data, resulting from sliding-friction of beets at the backside of the elevator. Yet normally the beets are carried by the individual conveying-elements. In order to elucidate the situation a systematical experiment with artificial plastic beets was set up aside from the harvesting season. The result rose by 7%, when the conveying-rate was stepwise increased from 10 to 30 kg/s. For comparison: 600 dt/ha in yield result in 16 kg/s conveying-rate with 1 m/s or 25 kg/s with 1,5 m/s velocity.

Figure 1 shows an example from field-experiments. The data are compared to the records from wagon weighing, which are set to 100. The records indicated increase approximately by 10% per 20 kg/s rise in throughput. If regression analysis is used for correcting, the error is reduced to ± 2%.

Additional research is necessary in order to take these errors into account when calibrating or making changes in the design of the conveyor-duct. Calibrating is complicated, since the actual mass-flow-rate cannot be recorded continuously; instead only the total mass of several t within the bunker is available as reference.

The recording-system indicates the total power for driving the conveyor. From this the power, for the idle running conveyor should be subtracted as tare, which is important since it takes about half of the power. Several factors influence the results.

In the cold machine the hydraulic-oil is highly viscous, this increases the power needed. Within a few minutes the temperature

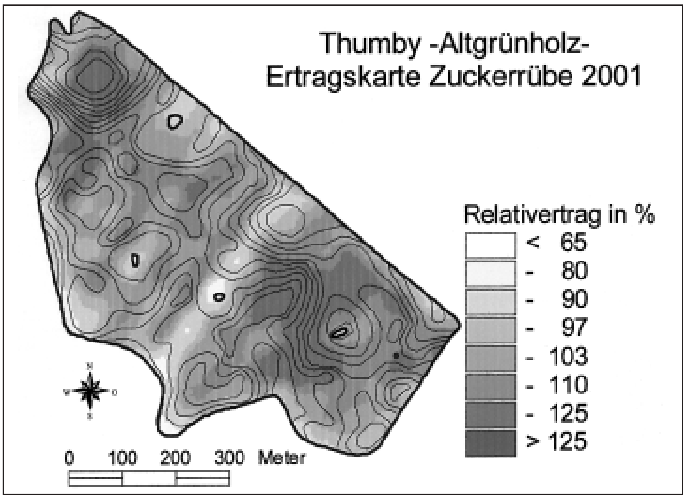

Fig. 2.: Yield-map for sugar beets and contour lines on a 40 ha field

attains the operational constant level. A temperature-indicator can be used for controlling the warming-up. Soil conditions as influenced by rainy or dry periods or by the texture are very important, since they can influence the resistance within the conveyor. This can be corrected via the idle-power, e.g. during turning at the headlands. A computer-program can provide for this automatically as soon as the beets are delivered. For this purpose, the driver views the pattern of the curve on the monitor. He stops the recording manually or automatically when the lifting-shares are engaged. A long recording time can result in cleaning of the conveying-line and thus in a decrease of the idle-power. The whole process can be automated: correction occurs within a limited time or is stopped when a definite slope of the recording-curve is attained.

The interest and care of the driver are an important prerequisite for a functioning system. The driver views the pattern of the curve, he can see clogging during conveying or because of an overfilled bunker.

Yield-mapping

As a result of the recording the mapping of the yield presents information about soil and production-techniques.

With site-specific farming it is interesting to know, whether differences in soil-quality can be seen from year to year. This is demonstrated as an example by a field, which was used, by Reimers (Soil-Information, Kiel) within a pre-agro project and the rotation rape-winter barley-sugar beets-winter wheat. The yield-map for the beets shows a span of ± 30% (*Fig. 2*). The reduced yields at the edge of a forest and for a part field in the Northeast of the field lead to question whether the production at all or yield increasing operations such as fertilising or plant-protection here is worthwhile. A strip transects the middle of the field, which at first was identified as a recording error, later however recognised by farm-helpers as a previous location of a hedge. This strip cannot be seen in cereals, in rape it is hardly noticeable.

The high-yielding partial areas are located on colluvial fen-gley. This indicates influence of water and slope. These partial areas result in high yields with cereals as well. Higher located areas (30 m) show average yields, whereas areas which slope down by 10 m yield high. In lower areas the wheat yields are reduced in case the soil is a sandy-loam. In these places the beets yielded better.

The diagonal transect of the field shows the yield-pattern for a length of 1 000 m and for 4 crops (*Fig. 3*). The higher yield of the beets at the start may be caused by the direction of the slope, for wheat the inclination of the slope may be important. At 600 m the strip shown in Fig. 2 again is indicated. The growth of rapeseed was impaired by wet depression, especially in colluvial fen at 750 m.

A comparison like this over several years should not only be calculated mathematically, in addition the data should be interpreted while looking at special situations of weather and growth. Such a vertical comparison presents information about a field, the horizontal comparison of several fields exposes differences in the production-techniques.

The yield-maps of different farms show diverse specialities in the agronomic management and quantify its significance. In one example a strip with a yield-increase of 15 t/ha resulted from the fact, that the manure-spreader had passed once more because of unfavourable driving conditions. In another case the effect of a fungicidal treatment amounted to 10 t/ha. The farm-manager doubted, whether spraying in August still might be useful, and therefore did not treat the whole field.

These are effects, which the farm-manager cannot see and recognise - contrary to the situation with cereals. Thus yield-mapping offers a control-system and improves the knowledge about soil and production-techniques.

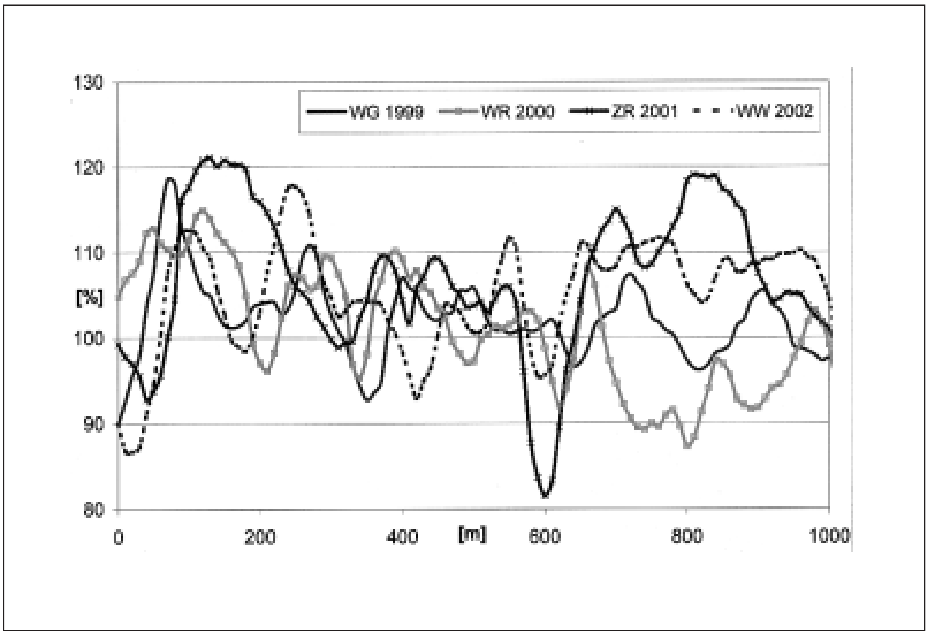

Fig. 3: Course of yield (relative) of several years in the diagonal direction of the field (from S/E to N/W)