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Current technology in sugar beet harvesting

Seligenstadt 2000 beet harvester test

Optimising the harvesting process can only succeed through considering alternatives in the component parts of the operation. This applies especially in sugar beet and means current technology level should be looked at only in the context of test year, location, crop variety, cultivation technique and harvest time. This is why beet harvest demonstrations have been located at a single site since 1984 with transport management also tested – loading and cleaning equipment – since 1988. Location is Seligenstadt estate near Würzburg with 16 systems tested on October 9 and 10, 2000.

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Results always represent only a momentary recording on the test day in question and this means that their critical classification is only possible when test procedure and conditions are known. Recording methods for quality criteria weight loss, head quality, beet surface damage and earth proportion is determined in a IIRB test standard [1] and the test conditions are summarised in *table 1*.

Technological standard

The technological standard was fully documented in a demonstration catalogue [2] and is summarised in the test final report and type tables [3]. Characteristic of developments is a growing uniformity of the technology on offer from individual manufacturers, sufficient engine power, more operator-friendliness through electronic control and regulating circuits, the use of large-volume tyres for avoiding soil damage and, nowadays, the clear dominance of six-row bunker harvesters the proportion of which in some European beet regions reaches up to 100%. Machines from manufacturers from seven countries were tested. Average installed power for KRB6 machines is 52.6 kW/R compared with the required power for pulled two and three row bunker harvesters of 64 kW/R. Specific KRB6 bunker capacity is 2.8 to 4.7 t/R, as with the KRB3. The KRB2 figures are higher. Maximum KRB6 width for the 50 cm row centres for all makes was 3 m.This was to be expected with track widths of 2.20 to 2.45 m and 710 to 800 mm tyres. Most commonly used tyre sizes were 800/65 R 32 and 1050/50 R 32. A growing uniformity of technology on offer was reflected in all manufacturers using flail choppers for defoliation and skid sensors with fixed knife as precision topper (only one disc topper). All six row harvesters (self-guidance) used polder shares as block or changeable arm with an oscillating or parallel guidance of ±25 to 40 mm. Practically all the sieve star revolutions in the different areas could be mechanically or hydraulically adjusted. For transport after the share, six of the manufacturers used lateral roller systems, four manufacturers – and all the

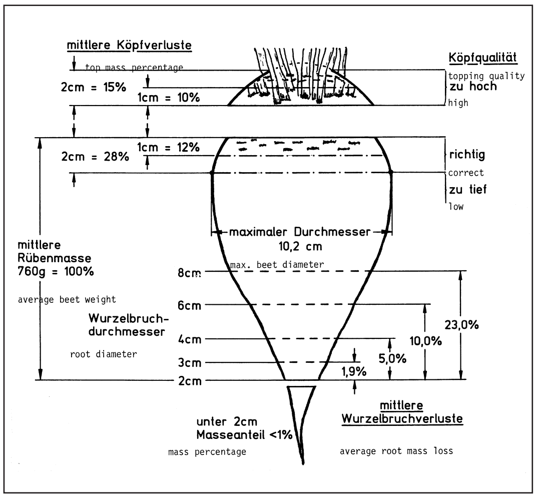

Fig. 1: Average root breakage loss in Seligenstadt

Test location	Gutsverwaltung Seligenstadt Stiftung Juliusspital Würzburg 97279 Prosselsheim-Seligenstadt
Soil	Para brown earth
Soil type	Silty clay-loam
Soil moisture content	24.1-28.3 %
Precipitation	10,5 mm on 9.10.2000 am 1,9 mm on 10.10.2000 am
Temperature	8.3 °C average air temperature 9.7 to 10.4 °C soil temperature (5 cm below surface)
Cultivation system	Conventional Deposition on end distance 19.5 cm Row centres 50 cm
Variety	Corinna (KWS)
Plant population	90016 beet/ha
Yield	68.4 t/ha (correctly topped, beet only)
Individual beet weight	760 g
Sugar content	17,6 %
Beet morphology	Average / Proportion Crown thickness 22 mm / 37 % Division 62 mm / 36 % Max ø beet 102 mm / 19 %

Table 1: Test conditions

Table 2: Quality criteria average in association with harvesting system and row number

Harvesting system ( ) = Repeat	Driving speed	Earth proportion	Surface damage[1)]	Weight loss[2)]	Head quality[3)] not	acceptable	too low
	km/h	%	cm²/100 R	%	%	%	%
KRB 2 (n=2)	5,5	13,0	200	2,8	12,0	84,6	3,9
KRB 3 (n=2)	5,3	9,4	348	2,8	5,4	88,3	6,5
KRB 6 (n=10)	5,4	10,0	225	3,5	10,3	82,8	6,9
KR + LB (n=2)	5,4/6,1	13,7	115	3,5	9,3	86,9	4,0

[1]) Damage without head cut area, root breakage areas and over 3 cm damage length (systematic measuring error > 300 cm 2/100 roots

[2]) Total weight loss

[3]) IIRB classes"leaf stem >2 cm" and"not topped" to"not topped","too high" and"correctly topped" to"acceptable" and"too low" and"squint headed" to"too low" summarised.

pulled KRB – used sieve stars. An expected improvement featured reversible variable rollers in the pick-up areas. All machines could be adjusted for row widths of 45 and 50 cm. Specific capital requirement (incl. VAT) was 105460 DM/R for KRB6, 58155 DM/R for KRB2 and 47364 DM/R for KRB3.

Capacity

Throughput wasn't looked at in the tests. This can, however, be calculated with driving speed and an assumed consistent yield plus a taken earth proportion (tare) *(table 2)*. Manufacturers' figures gave harvesting speed as between 4.5 and 7 km/h although this was not reached under the given conditions. Average harvesting speeds: KRB2 5.5 km/h, KRB3 5.3 km/h, KRB6 5.4 km/h and, in the two phase harvesting systems, 5.2 to 5.6 km/h for the KR 6, KR8 and, with the loading bunkers, 5.8 to 6.3 km/h.

Work quality

Soil tare in the 2000 test, with site soil moisture at 24.1 to 28.3% was significantly higher than in the years 1992 and 1996. Soil proportion with KRB2 machines was 13%, with KRB3 9.4% and with KRB6, 10% (*table 2*). As only two machine types were in test, the averages weren't particularly significant. Because of the soil structure protecting tyres used, influence of harvest depth on soil tare was difficult to evaluate and is thus ignored in the resulting presentation.

The *beet surface damage* did not take account of the unavoidable opening of the beet through topping and root break. Thus recorded surface damage represented only a fraction (~ 10%) of actual epidermis damage. After a manual check for damage (5•100 beet per harvester) only damage was recorded where it comprised 3 cm and above. This led to a systematic error and in practice excluded the acceptance of an average in the area of 115 - 348 cm²/100 beet.

Weight loss was determined as over and under earth loss through lifted or outfall beet, or pieces of beet over 4.5 cm side length and, together with weight loss through broken root tips above 2 cm diameter, added up to give a total weight loss (table 2). From this, a representative beet for the crop on the test area (*fig. 1*) was determined, which also demonstrated the importance of correct topping. The formula used nowadays for determining weight loss penalties resulted, with same variable costs and yield on the test field, with around 60 DM/ha for A-beet and 16 DM/ha with C-beet at 1% weight loss.

Top quality must be considered in the context of foliage recovery having no longer any importance in Germany. The evaluation took place according to the IIRB standard [4, 5] through estimation. Because of the difference in interest from farmers and sugar technologists it is in practice often difficult for the manufacturer to present the harvester for "correct evaluation" – a condition that is basically determined through the quotas. To avoid molasses development in the harvested roots, and for achieving an as high as possible potential yield, the proportion of "leaf stem over 2 cm" and "not topped" as well as "too low" and "topped at an angle" has to be kept down. For an improved documentation of the top quality technically possible, the result presentation comprises only three classes (table 2). Hereby the beet recorded as "acceptably topped" averages 84.6% for KRB2, 88.3% for KRB3, 82.8% for KRB6 and 86.9% with KR + LB.

Table 3: Effect of harvest time and soil moisture content on the average value for quality criteria comparison with KRB6

Date	Soil moisture	Driving speed	Soil proportion	Surface damage[1)]	Weight loss[2)]	Head quality[3)] not	acceptable	to low
	%	km/h	%	cm²/100 R	%	%	%	%
10.10.	27,1	5,5	13,0	200	2,8	12,0	84,6	3,9
11.10.	25,7	5,3	9,4	348	2,8	5,4	88,3	6,5

[1]) Damage without head cut area, root breakage areas and over 3 cm damage length (systematic measuring error > 300 cm 2/100 roots

[2]) Total weight loss

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Critical evaluation

Because of the altered bulk management of sugar beet with only field-edge storage in individual regions, conditions for technical adjustment of harvesters have changed in that, following a week's storage between harvesting and transport and cleaning loaders with cleaning rollers, soil tare can be cut by up to 70% and practically all leaf parts separated out. For this reason a reassessment of IIRB standards by an international working group is to be expected during the current year. The considerable influence of location and harvesting conditions was demonstrated by comparing results from the same harvester used at the beginning and the end of the test (*table 3*). A one-day test as part of a machinery demonstration can therefore not take the place of a long-term test, for instance in the form of a DLG-trial.

Literature

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