Peter Schulze Lammers and Matthias Rose, Bonn

Harvest Quality of Six-row Sugar Beet Tanker Harvesters

Test of Lifters 2004 in Seligenstadt

In October 2004 three sugar beet harvesters were tested regarding harvest qualities. The test was characterised by difficult soil conditions, due to heavy rainfall in the preceding days. Mass losses of harvested sugar beets were less than 4.1 %, over 72 % of the beets were topped correctly according to the definition in the IIRB standard, and soil tare was less than13.4 %. However, none of the harvesters had the best results in all quality criteria. The newly designed Maxtron by Grimme achieved the same quality level as the harvesters from the companies Holmer and Ropa, already present in the market.

Prof. Dr.-Ing. Peter Schulze Lammers and Dipl.-Ing. agr. (FH) Matthias Rose are members of the scientific staff at the Institute of Agricultural Engineering of the University Bonn, Nussallee 5, 53115 Bonn, in the section „Technology of Crop Farming“; e-mail: *lammers@uni-bonn.de*

Keywords

Sugar beet harvest, harvest quality, sugar beet harvester

Literatur

References can be retrieved under LT 05506 at http://www.landwirtschaftsverlag.com/landtech/local/fliteratur.htm.

In the last 20 years, the technology employed in the sugar beet harvest has developed towards multi-row systems. At present, six-row tankers are used on approximately 74 % [1] of a total cultivation area of 445,000 ha [2]. The dominant technology in Germany is the use of tankers, i.e. field capacity is understood to include not only the lifting of beets but also the clearing of the field by moving the beets to the headland with the harvesters. With increasing yield (in the last seven years there was on average an annual increase of 1.2 t/ha [3]) and with larger plots (in the last seven years the average cultivation area per farmer increased by 12 % [3]), the capacity requirements of beet tanks have risen.

Organised in cooperation with the Association of Franconian Sugar Beet Cultivators, harvester tests have been carried out at Seligenstadt near Würzburg since 1980 on a soil typical of beet cultivation in Germany. Ever since 1980, the harvester tests have been carried out in accordance with the same procedure, which was developed mainly by Brinkmann and Kromer [4, 5, 6] and standardised by the IIRB. As applicable to sugar beets, this standard deals with the sugar beet harvest, consisting of procedures for evaluating topping quality, for determining underground and aboveground mass losses and cleaning quality, which is evaluated on the basis of soil tare and surface beet damage.

Description of location and population

The harvesters were tested on a leached brown soil consisting of loess and silty loam and with an average soil water content of 28.3 %. Thus, the soil conditions must be regarded as critical with regard to trafficability and soil separation.

The population density (variety: Corinna, KWS) was 96,800 plants per ha, with an average beet mass of 874 g. This accounts for a theoretical yield of 84.63 t/ha, which is not attained in practice as a result of losses due to root breakage, topping losses and other mass losses.

The most important crop parameters, which were determined five days before the harvester test, are summarised in *Table 1*.

On 19 Oct 2004 the morphological characteristics of a total of 1,000 sugar beets were established on the test field near Seligenstadt.

Selection of the machines under test

Important criteria in the choice of the harvesters tested was the market share of this machine type and the harvesters’ degree of innovation. Accordingly, only self-propelled six-row tankers were taken into consideration. Two harvesters (Holmer Terra Dos and Ropa Euro-Tiger) are equipped with polder shares and turbine cleaning elements. One harvester (Grimme Maxtron) has driven wheel shares for lifting and spiral rollers for cleaning the beets (see *Table 2 and 3* for further technical data).

Explanation of the test procedure

Topping quality

Topping quality is determined in accordance with the categories introduced in the IIRB standard. To this end, 500 beets per harvester were classified. Beets are regarded as „topped correctly“ if they are topped with a cut in the area between the upper crown growth part and the maximum beet diameter. The class of beets topped too high is subdivided into „untopped“ if the cut leaves petiole

Table 1: Crop parameters for the test plot October 2004

Plants /ha	row width	seed target spacing	top size Ø	topping height Ø	beet diameter max. Ø	beet mass Ø	yield theor.	yield actual Ø	sugar content Ø
96800	50 cm	19,5 cm	45,9 mm	16,9 mm	98,7 mm	874 g	84,6 t/ha	73 t/ha	18,7 %

	Holmer Terra Dos	Grimme Maxtron	Ropa Euro Tiger
Defoliation and topping	integral topper and sled positioner topper		
Lifting	Polder shares with counteracting single swingers	driven wheel lifting shares selfaligning	Polder shares with counteracting single swingers
Cleaning	turbines	spiral rollers	turbines

Table 2: Synopsis on six row harvester systems

	Holmer Terra Dos	Grimme Maxtron	Ropa Euro Tiger
Engine	338 kW	335 kW	415 kW
Tank volume	25 m^3	30 m^3	40 m^3
Net weight	25700 kg	31600 kg	31500 kg
Chassis	wheels, 2 axles	rubber track	wheels, 3 axles

Table 3: Synopsis of technical data of six row harvesters tested

stumps of 2 cm or more, „under topped" if the petiole stumps left by the cut are shorter than 2 cm, and „under topped with no petioles" if there are no petiole stumps left but the green growth part of the crown is still visible. „Over topped" have been topped below the maximum beet diameter, and in beets in the „angled topped" category the cut starts below the maximum beet diameter, ending in the area of the beet crown.

Mass losses

Mass losses occur as a result of root tip breakage occurring in the lifter; they are determined after lifting by measuring the breakage diameter with a ruler. The results presented in *Table 4* were produced by means of a function from the IIRB standard; they take into account the average beet mass of the beets in the test.

Additional mass losses are caused by beets which are not lifted, which remain in the soil (underground mass losses) and beets which are not picked up or which fall from the harvester (aboveground mass losses). Underground mass losses are determined by two passes with a spring-tine cultivator and subsequent beet gathering. Only beets and utilizable beet fragments more than 4.5 cm in diameter are taken into account for aboveground losses. Smaller beets which fall through the openings in the harvesters' cleaning devices are regarded as unavoidable losses.

Soil tare

The soil tare, which consists of loose soil deposited with the beets in the clamp at the headlands and of the soil adhering to the beets, is determined by weighing and washing the beets. To this end, the beets are bagged during unloading from the harvester, and the loose soil and the cleaning losses are determined by gravimetry.

Results of the harvester tests

Mass losses

In the 2004 harvester tests, aboveground losses were between 0.3 and 0.5 % for all three harvesters. If the variation of the values is taken into account, there is no statistical difference between the brands tested. Underground losses, ranging between 0.1 and 0.3 % of the harvested mass, are lower than aboveground losses. In this regard, the Ropa Euro-Tiger performs better than the other harvesters, which can partly be attributed to differences in lifting depth, which setting was deepest on the Euro-Tiger. Root breakage, which is the main cause of mass losses in beet harvesting, was between 1.6 and 3.3 % in the harvesters tested. As regards work quality in this respect, the Grimme Maxtron clearly stands out from the other harvesters. This is also manifest in total mass losses, which were only 2.3 % in the Grimme Maxtron. The harvester design with driven wheel lifting shares and cleaning by spiral may be assumed to have proven under the conditions of this test.

Soil tare

Under the truly difficult soil conditions on the test day, with a soil water content of 28.3 %, harvester performance (theoretical average throughput of the harvesters: 123.5 t/h) was limited by soil separation and cleaning. As a result, soil tare was established to range between 11.8 and 13.2 %. A comparison with the results of the harvester test in 2000, which took place under similar soil conditions, shows the same range of values between 10 and 14.2 % for the two harvesters available in the market at that date [7].

The new harvester design comes off no better in this criterion of work quality than the other harvesters. In conclusion, soil separation may be regarded to be as efficient in the turbine harvesters as in the harvester with spiral roller cleaning, at this stage of development.

Topping quality

The settings of the toppers were made by the manufacturers in line with the settings generally used in field work, i.e. the toppers were set in such a way that the percentage of beets topped too low was small, whereas the percentage of correctly topped beets was high and a significant percentage of beets topped too high was accepted. Given the mass losses due to topping, this way of setting the toppers seems reasonable because topped too low may result in mass losses of up to 20 %.

A comparison of the values for the three brands in *Table 4* shows minor differences in the category of correctly topped beets. The toppers had been set very high on the Euro-Tiger, which led to a high percentage of beets topped too high (almost 20 %) and, consequently, to a very low percentage (3.2 %) of beets topped too low. Since no further assessment of mass losses due to topping and no assessment of processing quality was carried out, a conclusion that may be drawn at this stage is that the topping equipment in all three harvesters can be set very precisely.

Table 4: Results of six row harvester test, Seligenstadt 2004

	speed	mass flow	lifting depth	soil water content (dry based)	soil tare	mass losses, relative				topping quality					
						on soil	sub soil	tip brakeage	total	petioles > 2 cm	under topped < 2cm	under topped no petioles	correctly topped	over topped	angled topped
	km/h	t/h	cm	%	%	%	%	%	%	%	%	%	%	%	%
Grimme	5,9	128,8	8,5	27,2	11,9	0,4	0,3	1,6	2,3	0,0	0,2	16,4	71,2	10,8	1,4
Ropa	5,5	121,1	9,4	28,8	13,2	0,3	0,1	3,0	3,4	0,2	1,8	19,1	73,5	3,2	2,2
Holmer	5,5	120,6	8,1	29,1	12,0	0,5	0,2	3,3	4,0	0,2	1,0	11,2	72,9	12,2	2,6