Field Research Equipment for Sugar Beet

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Introduction

The design and validation of farm machinery as well as field practices needs precise measuring systems and equipment for evaluation. This includes also equipment for measuring biotechnical properties of the sugar beets. Sticky belt systems and plant counters, some of them with opto-sensors were used to measure the working quality of precision seeders by means of the uniformity of the seed frequency and plant stand. Most of these systems have been very time consuming; therefore, data could not be taken in real time. Use of simple equipment was also time consuming and limited the number of replications when measuring physical properties of beets. Site specific cultural practices; i.e. mulch seeding for erosion control require rainfall simulation and site specific harvesting.

Objectives

For meeting the before mentioned requirements, appropriate equipment was developed and tested under field conditions. Measuring systems for the seeder laboratory tests had to be designed in detail and built, on-farm test and field test. Systems for taking beet characteristics were also developed, as well as for rainfall simulation and yield measurement.

Measuring System for Laboratory Seeder Test

A system was developed that included an electronic light frame and a flap controlled seed collector .It is connected to a PC through an RS232, **fig 1.** The operation of the system and the documentation is accomplished by computer software. The system counts all seeds with a diameter larger than 1 mm. The replication frequency of the light frame is 5 kHz which gives a pulse(recognition) time of 0.2 ms.

During the test process, the light frame is placed at the level of the seeder share base, **fig.1.** Every seed causes a signal, except when two seeds are one behind the other.

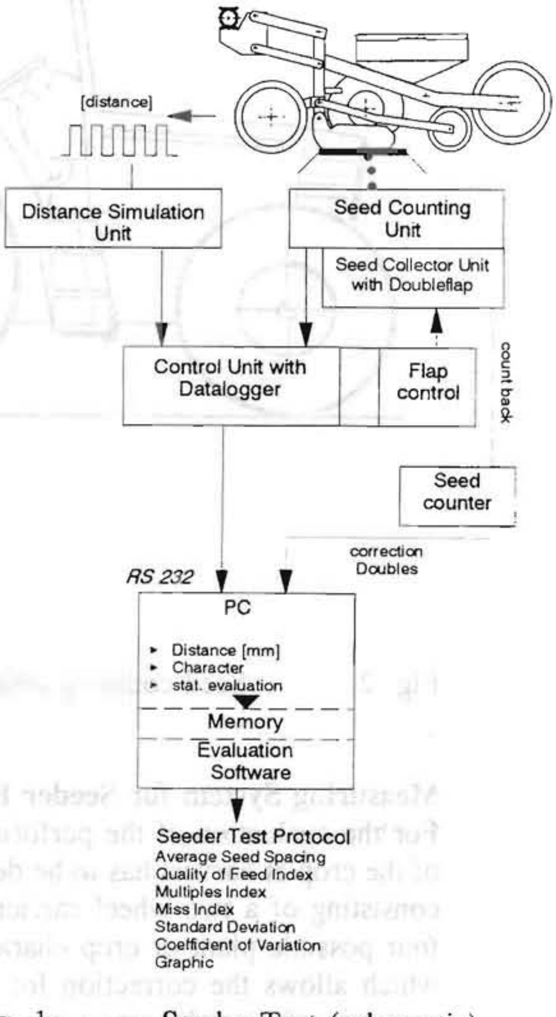


Fig. 1: Seeder Test (schematic)

A flap mechanism allows all seeds to be collected when the test process is started. With a seed counter, the true number of seeds are determined. The different number of the seeds in the collector unit and the number of signals from the light frame are called multiples, with the distance 0 mm. The nescessary spacing signals are given by the distance simulation unit. The seed spacing is calculated from the seed signal by the light frame and the distance signal of the simulation unit.

Measuring System for On-Farm Seeder Test

For evaluating the real boundary conditions of seeding, precision seeders eventually must be tested on the farm. Therefore a mobile test unit was developed by modifying the laboratory unit.The speed of seeding is applied by a belt drive unit to the ground support wheel, **fig.2**. The test time required is 5 minutes per seeder unit plus the time for the basic installation.

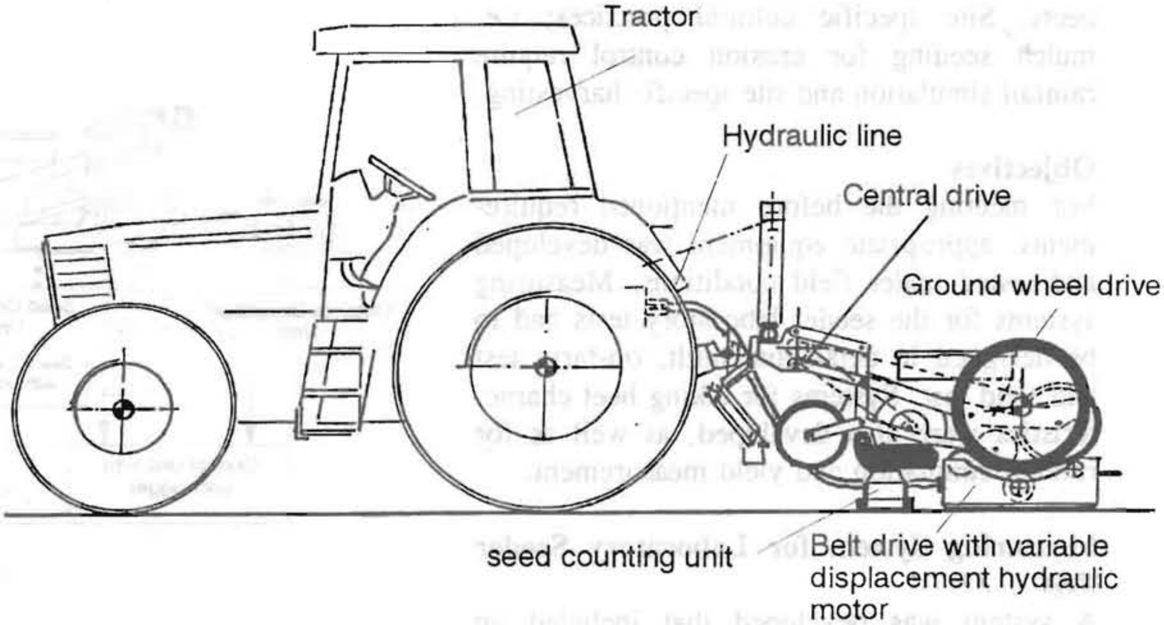


Fig. 2: Seed counting unit with belt drive.

Measuring System for Seeder Field Test

For the evaluation of the performance of a precision seeder, the quality of the crop stand and of the crop at harvest has to be determined. A field plant distance measuring unit was designed, consisting of a two-wheel carrier with a distance impulse generator and buttons for recording four possible plant or crop characteristics, **fig. 3**. The distance signal is in 1 mm increments, which allows the correction for ground wheel slip using computer software by calculating a correction factor. Incorrect input signals on the characteristics are erased automatically by pulling backward. An opto-sensor for measuring seeds or plants can be installed as well as a mechanical operated plant counter. The unit includes a control unit with data logger for data transfer and a notebook computer with the software for documentation.

Documentation of Data

The documentation for all three systems is based on the ISO Standard No.7256-1 (1984), including the percentage of seeds or plants in the spacing range of 0,5 to 1,5 of the expected number of the seeds normally sown, including multiples and misses, **table 1**. The test report includes also the distance of the test, the field emergence, characteristics of the crop, and the percentage of seeds in the range of 30 mm and of plants in the range of 50 mm. An additional evaluation of the average spacing of seeds or plants for the precision seeder is made. The theoretical spacing is set on the control mechanism according to the manual of the manufacturer. The average spacing is based on the normal distribution of the actual spacing between the seeds or plants. The standard deviation is the measure of the precision seeder performance. The results are calculated from six replications. The test protocol printout includes all results and a histogram of the spacing frequency, **table 2**.

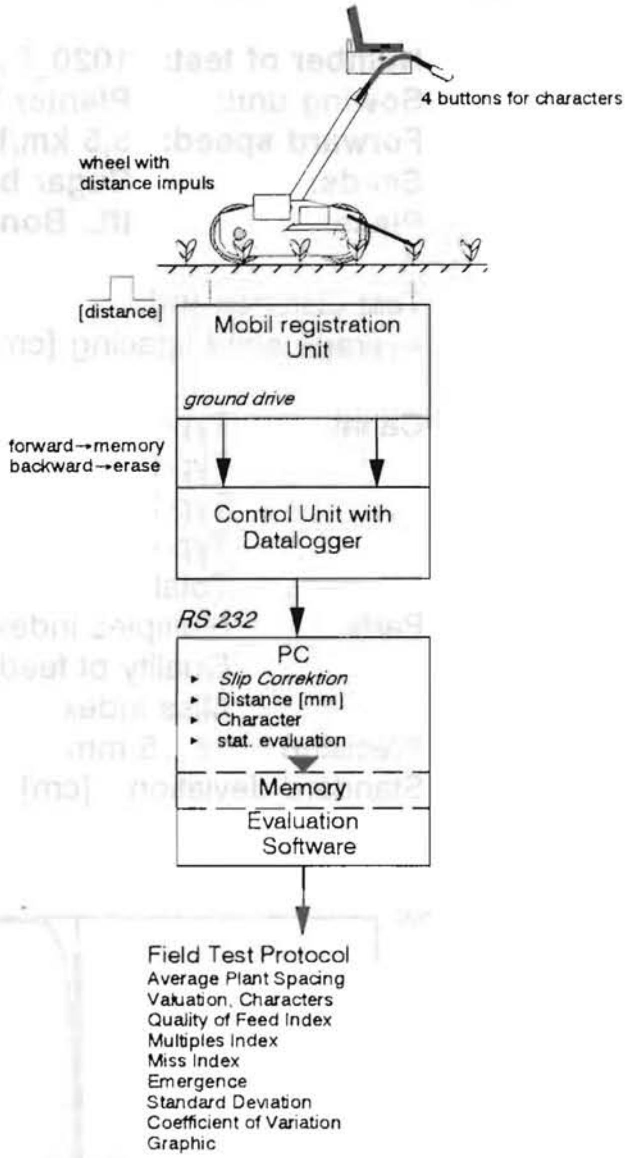


Fig. 3: Crop Test (schematic)

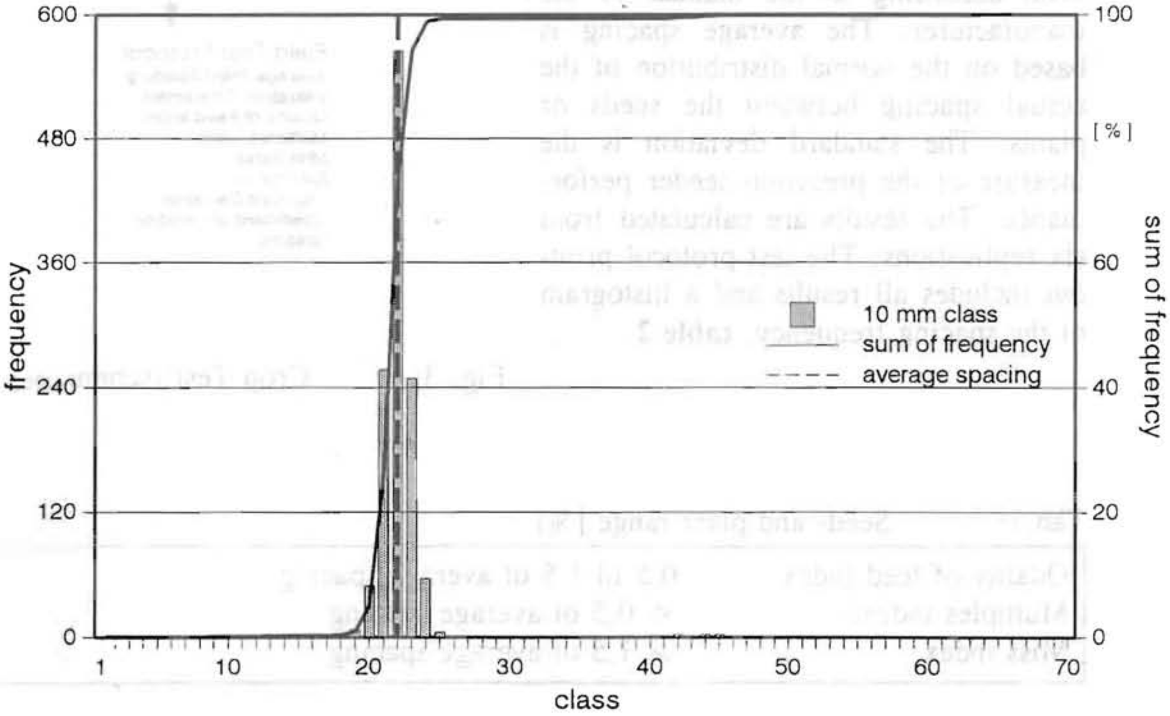
Tab.1: Seed- and plant range [%]

Quality of feed index:	0,5 til 1.5 of average spacing
Multiples index:	< 0,5 of average spacing
Miss index:	> 1,5 of average spacing

Tab.2: Test protocol

Number of test: **1020_F1.VEL**
Sowing unit: **Planter Typ "A"**
Forward speed: **5,5 km/h**
Seeds: **Sugar beet, pilled**
Place: **IfL, Bonn, Lab-Test**

Test distance [m]:		**265,03**	
Average seed spacing [cm]:		**19,95**	
		[Number]	[%]
Canal:	Typ 1	1200	**100**
	Typ 2	0	**0**
	Typ 3	0	**0**
	Typ 4	0	**0**
	Total	1200	**100**
Parts:	Multiples index	2	**0,3**
	Quality of feed index	1190	**99,0**
	Miss index	8	**0,7**
Precision	± 15 mm	1073	**89,3**
Standard deviation	[cm]	**0,96**	



Instrumentation for Measuring Beet Charcteristics

Measurements can be taken of the biotechnical properties and include beet top height, beet diameter, leaf growth and slice thickness when topping, **fig 4.**

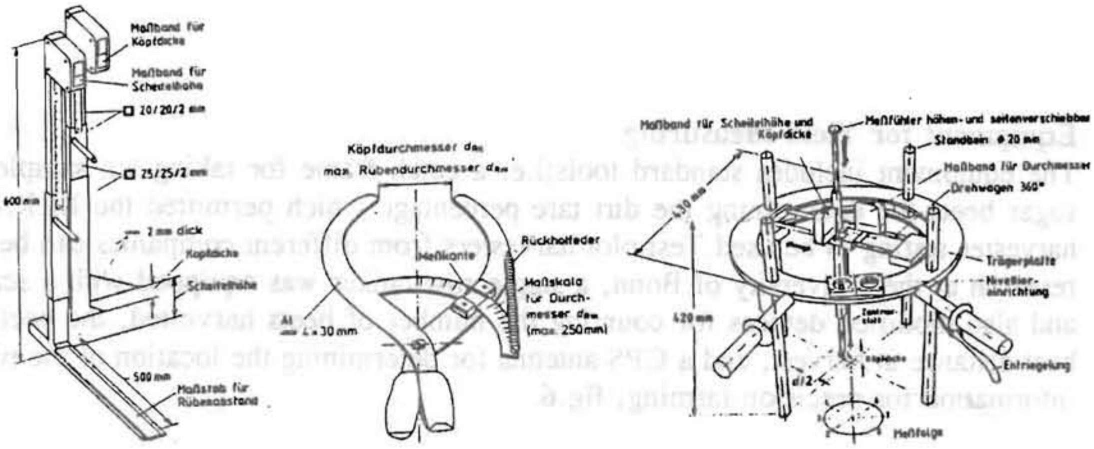


Fig.4: Measuring systems for biotechnical properties of Sugar Beet.

Equipment for Measuring Soil Conservation Effects

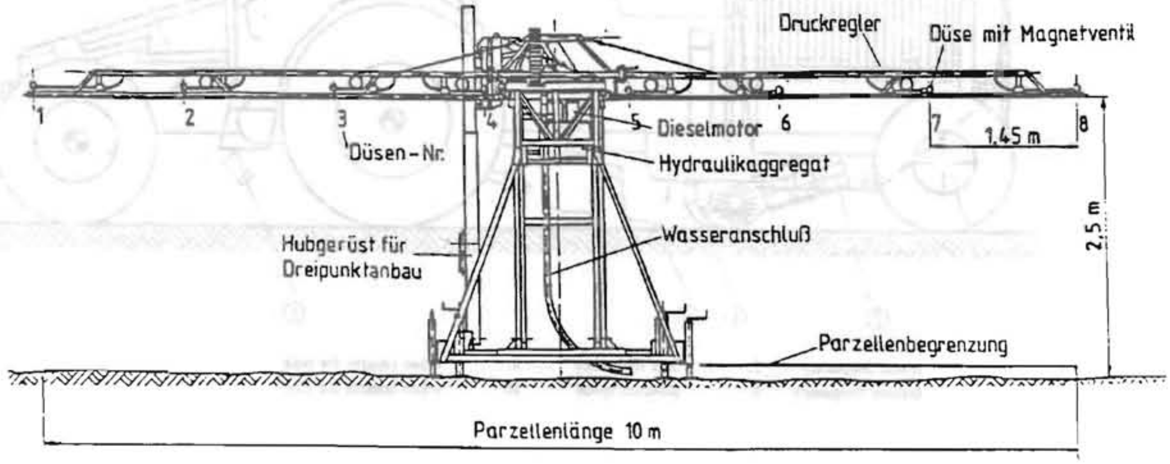


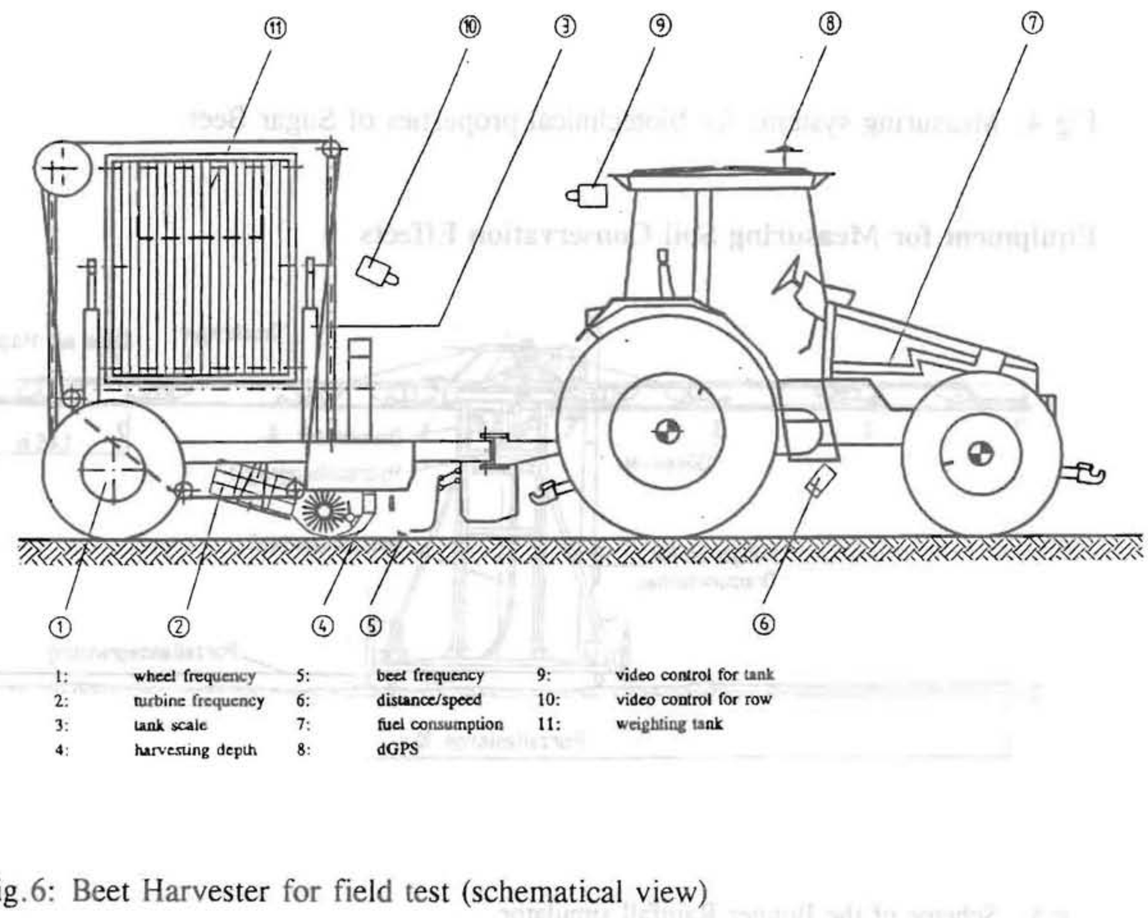
Fig.5: Scheme of the Bonner Rainfall simulator.

If mulch seeding is used tu reduce erosion, rainfall simulation is an appropriate method to measure the water run-off and the soil loss.

The technical equipment used are rainfall simulators. Because of the high water consumption of the USDA Rainfall Simulator by Swanson(1965), two new simulators were developed instead. One was a field rainfall simulator for plots of 4 x 10 m, **fig.5**, and a laboratory simulator for plots of 1x2 m . The comparison of all technical and quality data of eight rainfall simulators in Europe in use is available, Kromer (1996).

Equipment for Yield Measuring

The equipment includes standard tools;i.e. a catch frame for taking ten samples of 50 kg of sugar beets for determining the dirt tare percentage which permitted the I.I.R.B. standard of harvester testing to be used.Test plot harvesters from different companies can be used. For the research at the University of Bonn, a single row tanker was equipped with a scale in the tank and also modified devices for counting the number of beets harvested, the beet diameter, the beet distance at harvest, and a GPS antenna for determining the location of the plot and to gain information for precision farming, **fig.6**.



1:	wheel frequency	5:	beet frequency	9:	video control for tank
2:	turbine frequency	6:	distance/speed	10:	video control for row
3:	tank scale	7:	fuel consumption	11:	weighting tank
4:	harvesting depth	8:	dGPS		

Fig.6: Beet Harvester for field test (schematical view)

Summary
The Bonner Distance Measuring System allows the evaluation of precision seeders in the laboratory, on the farm, and in the field. The measuring systems enables one to evaluate seeders and the field crop in real time. The laboratory system may be used also in the phase of seeder design or predelivery inspection of seeders. By on-farm inspections, it assures the farmer of proper seeder adjustment and maintenance. In addition, a wide range of equipment for measuring the biotechnical properties of beets and the crop stand , the effect of cultural practices by rainfall simulation, and the site specific yield is avaiable. Their efficient use however is only assured, when the methods are precisely defined and standardized.

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