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A New Measuring System for Determining Plant Spacing within a Seed Row

Assessing the process quality of spacing drills is done in the field by determining the plant spacing within the row. A high resolution cable measuring system now makes this possible for drilled seed. This technique can easily replace time consuming methods with a tape measure or paper strips. The cable measuring system is considerably more accurate than the common methods for determining plant spacing.

The work quality evaluation of planters takes place by measuring the uniformity of the seed placement and the plant spacing. The plant spacing was only important for single seed planters and was used as assessment criterion. But plant spacing in the seed row more gets more important for seed drills, too. Developments of various companies for exact seed spacing prove this. The measuring systems provide a basis for technical optimisation and further development of seeding techniques. In a laboratory the seed spacing is usually determined by an light barrier but also the determination at the field work is rquiered to examine a machine. The uniformity of the seed spacing of single seed planters is typically determined by measuring the plant spacing. Normally you can assume an Gaussian distribution of the distances around an average distance, so you can use an Gaussian distribution for the complete characterisation [1]. For standard seed drills the plant spacing is according to an exponential distribution [2]. Because of the uniform plant spacing with an single seed planter is it easier to determine the plant spacing. Seed drills with narrow and non-uniform plant spacing make it difficult to determine the exact distances. Seed spacing of seed drills is randomly distributed. Cereals have an coefficient of variation between 110% and 120% [3]. Plant spacing between 10 and 20 cm with single seed planters are easier to detect than plant spacing between 2 and 8 cm with regular seed drills. Former methods with tape measure or slide gage are time consuming. Also the optical registration by the operator is not necessary [4].

Laboratory Measuring

As an laboratory system for measuring the distance of the grains, the Hohenheimer Optosensor Matrix 190 has been proven. The single monitoring of an light barrier, a short reaction time and an alternate arrangement of the emitter and the receiver add the system up to an exact measuring system for detecting the dropping place of the grains [5]. Results from the laboratory tests are to verify at field tests.

Cable measuring system

The cable measuring system developed in Hohenheim can be used for measuring the plant spacing within the seed row. It is applicable for single seed planters and standard seed drills. The evaluation of the plant spacing is important for optimal growth and high yields. The cable measuring system is a mobile device, that can moved over the field easily. At the inside of the device is the electric power supply and the position sensor with cable measuring system located. On the top of the device box is a notebook placed for da-

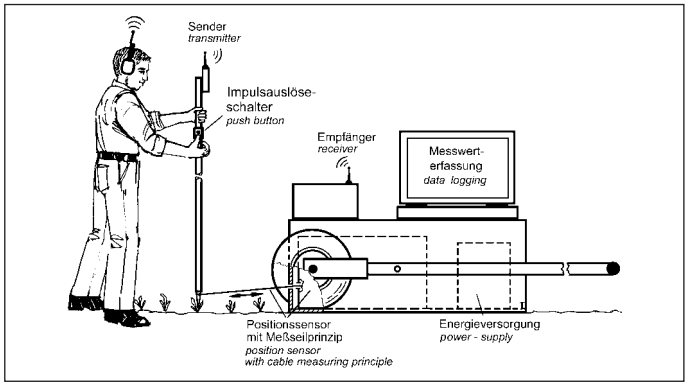

Fig. 1: Schematic exposition of the cable measuring system

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Keywords
Seed, plant spacing, measuring distances, measuring techniques

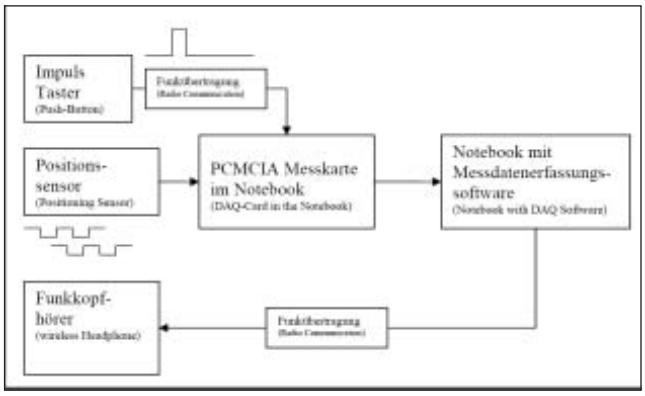

Fig. 2: Data flow scheme of the measuring system

ta storage and a radio receiver. For the measuring the operator has only to carry an aluminium stick with him. On top of the stick is a radio transmitter mounted and a switch to release the measuring pulse. Every measuring pulse recorded by the notebook is confirmed to the operator by an acoustic signal on the ear phone. During measuring the stick is placed next to the plant and the measuring pulse is actuated by the operator (*Fig. 1*). With a special software configuration it is possible to count forwards and also to correct a measurement backwards. The system has a resolution of 0.1 mm and so very exact measuring is possible. So sugar beets and maize can be detected at the seed leaf stadium. An accurate measuring of cereals is possible, too. Because of the high resolution and the easy manageability it is possible to detect cereal plants who are placed close next to each other. The recorded data are saved in a data record, which is compatible to the current software for analysis. At the beginning of measuring it is possible to define the number of distances to be detected within the seed row. An acoustic signal on the ear phone tells the operator the end of the measuring section. It is also possible to define the measuring section in which the plants are counted and the distances measured. So the operator can make defaults either e.g. by measuring the distances between 50 plants or to record the distances between the plants for a measuring section of 20m.

Assembly of the system

The cable measuring system is basically built out of four components: a position sensor with cable measuring principle, a pushbutton for saving the actual measurement, a DAQ-card and a laptop (*Fig. 2*). To attain a precise determination of the plant spacing, is it necessary to use a high precision measuring system. This is why the position sensor with cable measuring principle is used, which is equipped with an incremental encoder who releases 10 impulses/mm. With a simple incremental encoder and a counter input it is possible to count impulses but not to define a position. So a sensor with signal A and signal B (A 90°) is used making it possible to define the rotating direction with an quadrature encoder. The measuring cable is hung in the stick, which is equipped with a pushbutton to send a signal to the notebook, saving the position of the stick next to the plant. Impulses are transmitted by a radio signal, so no cables in the way are needed. The stored data by the notebook is copied by an acoustic signal to the head phones. This is very important for the operator to be sure that the system is working. Data logging works with an PCMCIA-card in the notebook, were a digital input and a 32bit quadrature counter input is used. The software used is "DASY Lab" by National Instruments, programmed that every measurement signal is written and saved in an ASCII file.

Conclusion

The cable measuring system developed at the Institute of Agricultural Engineering at the University of Hohenheim is qualified for determining plant spacing within a seed row. It is qualified for both single seed planters and seed drills and also for every kind of crops. Operators can vary the working speed in every row depending on the stand density. The measuring stick is ergonomically designed and adjustable to different operators. Measured distances can be included trouble free in every spread sheet software because of the ASCII-code, which is used in the system. Than they can be analysed by statistical methods. Because of the high release by 0.1 mm is a high accuracy warranted, supported by an easy handling of the measuring stick. Measuring distances up to 40 m and operating time up to twelve hours without an external power supply is possible. The compact construction allows an trouble free transport.

With the combination of the optical sensor Matrix 190 and the cable measuring system a complete measuring device is now available. With this system it is possible to test single seed planters and seed drills for grain spacing in the laboratory and the plant spacing in the field. The determination of the grain spacing in the laboratory and the plant spacing in the field are important criteria for the work quality evaluation of different planting machines. With this system it is possible to evaluate new equipment and also optimise new equipment in the construction phase.

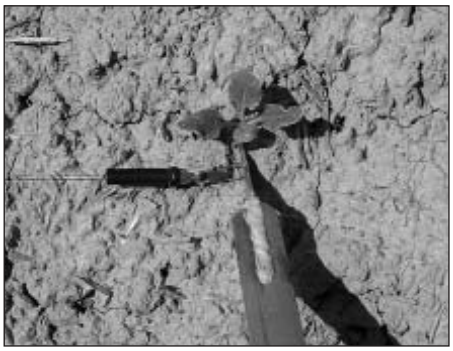

Fig. 3: Measuring stick with hung in cable

Literature

Books are identified by •

[1] *Griepentrog, H.-W.*: Bewertung von Längsverteilung bei Einzelkornsämaschinen. Landtechnik 47 (1992), H. 3, S. 123-125

[2] • *Heege, H. J.*: Die Gleichstand-, Drill- und Breitsaat des Getreides unter besonderer Berücksichtigung der flächenmäßigen Kornverteilung. KTL-Berichte über Landtechnik, Wolfratshausen, 1967

[3] *Wiesehoff, M., und C. Albrecht*: Kornlängsverteilung bei Drillmaschinen: Bessere Kornablage ist möglich. Profi 16 (2004), H. 8, S.??

[4] *Heier, L.*: Das Bonner Abstands-Aufzeichnungs-System. Landtechnik 51 (1996), H. 4, S. 204-205

[5] *Wiesehoff, M., J. Dreyer und K. Köller*: Untersuchungen zur Kornlängsverteilung bei der Drillsaat. Landtechnik 57 (2002), H. 5, S. 294