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Methods for the Evaluation of Straw Distribution and Incorporation

For reasons of soil protection and cost, stubble cultivation requirements have increased steadily. Even straw distribution by the combine and even incorporation by following stubble- and tillage implements form the decisive basis for successful seeding when ploughing is dispensed with. The evaluation of straw distribution requires aids. Below, methods for the evaluation of straw distribution and incorporation into the soil will be presented. The methods are designed for different demands.

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Keywords

Distribution of straw, incorporation of straw, soil tillage

The visual measurement of differences in straw concentration on the soil surface within a range of 0.50 kg/m^2 (50 dt/ha) to 1.5 kg/m^2 is impossible. The farmer is even less aware of the quality of straw incorporation. The methods for the evaluation of straw distribution and incorporation into the soil presented below are designed for different demands.

Methods for the Evaluation of Straw Distribution

Field Laboratory Method (Exact Method)
Straw distribution is measured at right angles to the driving direction according to a method first applied by Holz, Traulsen, and von Keiser. The straw is picked up with the aid of an aspirator from a ring with a defined diameter. Sampling begins centrally behind the combine and is continued to the right and to the left over the entire width (*fig. 1*). In addition to the measurement of the absolute straw masses, this further-developed method includes the determination of chopping quality by means of sifting analysis.

Fig. 1: Sample taking in the field

Field Method with Measuring Technology
Material:
Four marking posts, one tape measure, one rake.

At right angles to the working direction of the combine, a measuring area is determined, within which straw distribution must be assessed. The area should extend over at least two (or even better three) working widths of the combine and measure 3 m in the driving direction. At a combine working width of 6 m, this results in a rectangle of 18 m • 3 m. This area is marked at the four corner points. The entire straw mass is swathed centrally using the rake. Swathing is done from the outer limits to the middle at 2 • 1.5 m. The swath should be laid by only one person. This best guarantees even distribution. In contrast to the evenness of the swath, actual density is not decisive.

In the final photographic registration, the relative differences are recorded. The technique can be assessed using simple classification (*table 1*). The recorded data, compiled in tables and shown in a relative manner, allow measurements from different locations to be compared.

Table 1: Classifying proposals

1. Measurement of swath size in regular intervals using a tape measure
2. Measurement of swath height in regular intervals
3. Take photographs of the swath after setting up optical marking points (e.g. measuring rods). A coloured band on the surface makes the contours clearly apparent.

Manual Field Method
The simple manual method is suitable for quick measurement within a few minutes. Here, a swath is also generated manually over one to several combine working widths. The hands of a person serve as a rake (*fig. 2*). Since the range of an adult person is approximately 150 cm, the swath generated in such a simple manner is narrower than the one generated with a rake. Here, swathing should also be done by only one person.

Evaluation of the Methods
Due to the great time requirements, the field laboratory method is reserved for exact trials for professional combine evaluation. Since the laterally distributed straw masses are measured in the laboratory under controlled conditions, this technique only enables measurements to be compared which were taken at different locations at different times and

Fig. 2: Making a swath across the working direction of the combine

by different persons while taking the absolute straw masses into account. Both field methods are suitable for application in agricultural practice. The simple manual method has proven itself for combine optimisation before daily use. It is useful for daily application because experience has shown that day- and location-dependent moisture- and yield differences, as well as the change between grain varieties can influence the distribution pattern. The slightly more time-consuming field method, which includes the use of measuring technology, can also be suitable to employ the once reached optimization of a combine for the farmer's personal use and documentation in practice.

Method for the Evaluation of Straw Incorporation (Lattice Screen Method)

The time-consuming application of this measuring method requires patience and experience. The quality of straw incorporation is assessed in a cleared profile wall with the aid of a lattice screen.

Material
Board (length: 200 cm, width: ~ 20 cm)
Sharp hoe, shovel, watering can, classification lattice with a 4.5 cm • 4.5 cm grid, table, camera

Opening of a Profile Wall
This measuring method should only be applied at level locations after absolutely even straw distribution so that incoporation quality can exclusively be correlated with the tillage implement to be examined.

In the first step, the board is put on the ground at right angles to the combining direction and pressed onto the soil by treading. Then, a slit is hoed into the soil along the board edge. This is only successful if the hoe is sharp and the straw is severed immediately. Other techniques which allow the soil to be slit open easily are also conceivable. Subsequently, a ditch is dug free along the slit over two spade widths and at maximum tillage depth. The profile wall is thus opened. The described process requires experience and is not always successful immediately. On light, trickling, dry, sandy soils, the soil surface should first be watered with a can in order to avoid the collapse of the profile.

Preparation of the Profile Wall for Classification
In the next step, the uncovered profile is prepared for classification. Protruding straw particles are cut off using scissors, and the profile wall is reworked with a knife. In spots where straw particle shifting occurred during profiling rather than being the result of incorporation and where the straw particles are attached to the soil in the wrong spot (this is clearly visible), the necessary preparation work is carried out.

The board which is still lying on top for stabilization can now be removed, and the necessary preparations for the classification of straw incorporation are thus concluded.

Classification
Previous photographic documentation of the profile wall has proven itself. For optical support, a folding rule is put on the upper edge of the profile, which measures 200 cm, and a second folding rule is positioned at an angle such that the depth of the profile wall becomes apparent (*fig. 3*). Under unfavourable contrast- and light conditions, it may prove useful to mark the lower profile edge as well so that the transition from the profile wall to the profile ground becomes visible in the later photo. Above the profile wall, the photo should also show a few metres of the soil surface in the working direction in order to enable the remaining concentration and distribution of the straw on the surface to be evaluated at first glance in addition to incorporation.

Lattice screen classification now begins on the left side of the profile wall (fig. 3). One line level of the lattice screen borders the upper edge of the soil surface. For each screen cell in the profile wall, a classification step value (0 / 10 / 25 / 50 / 75 / 100%) is given and entered into a profile list (Excel table). For a better overview, evaluation should not be carried out in columns, but rather in lines.

After the lowest point of straw incorporation has been classified, the lattice screen is shifted to the right, and the process continues as described over the measuring width.

Fig. 3: Classifying with a lattice screen

A useful supplement to the recording of straw incorporation is the registration of related straw distribution on the surface. For this purpose, the lattice screen is put on the upper edge of the profile. Subsequent classification of straw distribution is not carried out for each screen cell (like in the profile wall), but only for each column. The degrees of coverage are entred according to the gradation that also applies to straw distribution.
Representation and Evaluation of the Results
The data entered into an Excel table are shown in colour gradations for optical recording. The sequence white (0% degree of coverage in the profile wall), gradations of yellow and brown, and black (100% degree of coverage) is well suitable. Colour gradation can also be shown in shades of grey.

Straw incorporation is all the better the smaller the colour gradations in the lattice screen are. In the ideal case of absolutely even incorporation, there is only one shade of light yellow over the entire incorporation horizon. The stronger the colour contrasts are, the more uneven straw incorporation is. In addition to the differences in concentration, the observation of even working depths over the profile width of 200 cm is shown.

Assessment of the Method
This method can easily be applied on firm soils at a medium moisture degree. Dried-out, trickling sand soils, however, cause problems. In this case, previous wetting is necessary. On soils containing many stones, the clean uncovering of a profile may be problematic as well. If all instructions are followed, this method must be classified as time-consuming. The generation and evaluation of a profile takes approximately 30 to 60 minutes with two persons working on it. The method enables measurements taken at different locations, at different times, and by different persons to be compared.