Hans Sonnenberg and Jennifer Schilf, Brunswick

Straw Litter for Animal Housing

Influence of Treatment on Litter Quality

If one favours littered animal housing and strives to reduce the labour-technical and economic disadvantages of this technique by treating the litter material, it turns out that positive effects can be achieved with little additional expenditure. Even though neither the sorption of faeces and urine is improved nor material is saved, the better logistic characteristics, the possibilities of dust reduction, and the improvement of the handling, distribution, and nutrient utilization in the soil of solid manure provide benefits.

Dr.-Ing. Dipl.-Ing. Hans Sonnenberg is a visiting scientist, and Ms. Jennifer Schilf was an agricultural-technical assistant at the Institute for Production Engineering and Building Research of the Federal Agricultural Research Centre (FAL), Bundesallee 50, D-38116 Braunschweig; e-mail: *hans.sonnenberg@fal.de*.

The authors would like to thank the German Federal Foundation for the Environment (DBU) for its financial support and the colleagues from the field of agricultural engineering in the Department of Ecological Agronomy of the University of Kassel as well as the company HAWE-Wester, Wippingen, for their helpful cooperation.

Keywords

Straw treatment, litter, animal housing

Literature

Literature references can be called up under LT 03107 via internet http://www.landwirtschaftsverlag.com/landtech/local/literatur.htm.

While species-compatibility and ecology speak in favour of littered animal housing in agriculture not least because of the soil-improving effect of the solid manure, the procurement and management of straw as well as the required manual labour impair profitability. Suitable mechanical straw treatment is expected to solve this problem. The literature provides a large number of very concrete recommendations along with information about the kind and benefits of different methods of treatment. Chopping, for example, would allow the water sorption capacity of straw to be increased by approximately 60% [1]. Enough straw is available in Germany – though not always where it is required. 30% of the approximately 42 million t/a alone would be sufficient for the animal-friendly, littered housing of one half of the cattle, pigs, sheep, goats, and horses (a total of ~19 million LU; 1 LU = 500 kg live mass). What treatment can actually achieve is examined and assessed through experiments in the laboratory and in practice.

Goals of Straw Treatment for Use as Litter

The kind and intensity of litter material treatment affect the following three areas:

1. The litter-/solid manure mattress, e.g. in a deep litter stall for cattle, should be characterized by a soft, deformable, and heat-insulating surface in order to offer comfort, the largest possible faeces- and urine sorption capacity, and joint protection. At the same time, it should be firm and elastic and, hence, have a bulk structure, which enables urine to be separated and thus the surface to be kept dry. In addition, its load-carrying capacity should provide sufficient resistance against the claw treading through [2].
2. Solid manure quality could be improved by short-fibrous, bulk material-like consistence because demanuring, transfer, even metering and distribution, as well as rotting and nutrient release in the soil would be favoured.
3. The following principle applies to the entire logistic chain: the more the product is similar to flowable bulk material, the easier the handling and use of continuous conveying- and distributing elements becomes. In addition, these elements can be encapsulated and, hence, designed as dust-tight units. High bulk densities require less storage- and transport volume.

Techniques of Mechanical Treatment

If the principles of mechanical comminution (cutting, i.e. shear- and knife cut, ripping, breaking (crushing, bending), impacting, and grinding) are considered, it becomes ap-

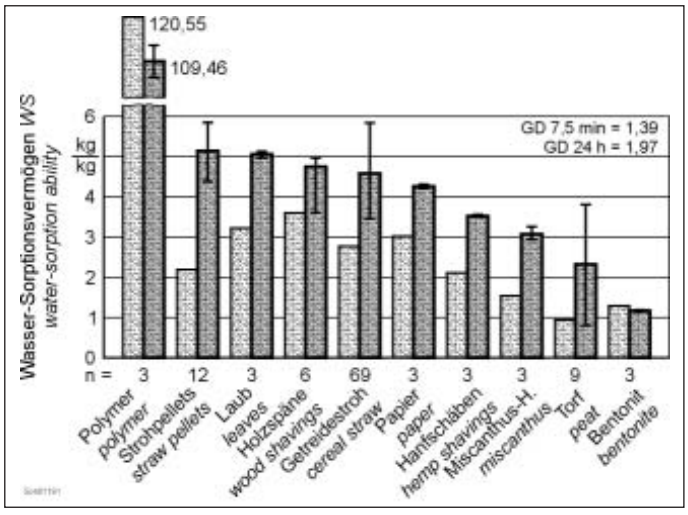

Fig. 1: Water sorption ability WS (sorbed water mass in relation to the dry mass of the sorbents) of different and differently treated litter materials with ad- and absorbing effects; left, clear column: value after a watering time of 7.5 min; right, dark column: WS value after a watering time of 24 h.

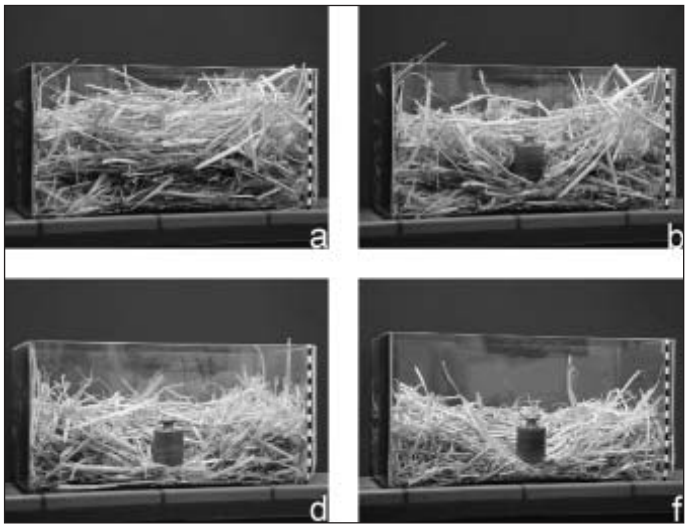

Fig. 2: Structural behaviour of differently treated litter material: a) long straw (initial material), littered; b) long straw, approximately loaded with the area pressure of a lying cow; d) straw after splicing treatment by a littering device with blunt tines and loaded with the same weight; f) straw treated by a device with sharp knives, loaded with the same weight. processed litter materials: a) long straw (basic material) litter; b) long straw, loaded with area pressure of laying cattle; d) straw macerated by a litter implement with dull teeth and loaded the same; f) straw processed with implement with sharp blades, loaded the same

parent that in this order the specific surface thus created and, hence, liquid sorption ability exhibit an increasing tendency, while bulk structure and mattress stability diminish at the same time.

All straw bale dissolvers, -distributors, and littering devices available on the market use mixing systems which cut, rip, and splice. Primarily, two basic carrying elements for comminution tools have established themselves:

- a rotating disc, which is either arranged horizontally or vertically
- one or several rollers, which generally lie in a horizontal position.

They are combined in many ways and supplemented with additional elements. In most cases, the material is advanced either by its own weight or a scraper floor.

Examination and Results of Mechanical Treatment

With regard to the three mentioned goals, the studies include the following parameters:

Liquid Sorption Ability of the Litter

Liquid sorption ability, which is often termed the most important litter characteristic, is examined at a half-technical scale according to a method developed by the authors. A comparison with different litter materials (*fig. 1*) illustrates that polymers used in pet husbandry, for example, surpass all organic and mineral materials almost 25-fold and that grain straw ranges in the medium organic range immediately after pellets, which have a larger specific surface due to their higher fine material content.

Structure of the Litter Layer

The structure of the litter-/solid manure mattress is seen as another significant target value. *Figure 2* provides an optical, purely qualitative impression of the behaviour of the different variants. The decreasing bulk heights in the figure parts b – d – f reflect the falling specific volume requirements. In the same manner, the continuously decreasing residual thickness of the material compressed under the weight shows that the structure of the layer deteriorates with an increasing comminution degree.

Required Litter Quantity

In supplementary studies, the influence of the kind and degree of mechanical treatment on relevant characteristics of litter and solid manure are being examined in five-year practice trials with a total of approximately 200 heads of cattle (always in three parallel groups). In all these trials, long straw as litter is being compared with a little- and a more intensively treated variant. Given species-compatible housing and animal cleanliness, the litter requirements as the decisive parameter are determined (*fig. 3*).

The mean values of the litter requirements of the three groups of treatment variants move like the steps of stairs (in figure 3 from left to right) from long straw $L_Ø$ with 3.5 kg/(LU•d) and cut material $G_Ø$ with 3.8 kg/(LU•d) to the chopped litter variant $H_Ø$ with 4.0 kg/(LU•d). The additional requirements of the cut material, i.e. the variant which has undergone little treatment as compared with long straw, amount to an average of 0.3 kg/(LU•d) or 8.6 %. The additional demand of the chopped litter material, i.e. the more intensively treated variant, even reaches 0.5 kg/(LU•d), which corresponds to 14.3 % [3].

Conclusions

In contrast to former expectations, the practice-oriented mechanical treatment of grain straw pressed into round bales does not enable its characteristics for the litter-/solid manure mattress to be improved. Advantages can be achieved with regard to handling, space requirements, and the use of dust-reducing conveying elements. Solid manure quality also improves in view of transport, metering, distribution, rotting, and nutrient release in the soil [4]. The logistics of both the straw and the solid manure are improved. Straw should undergo little treatment (baler with a cutter). This would allow the volume requirements to be reduced to one third and the litter demand to less than 4 kg/(LU•d). Softness and structure and, hence, separability and resistance against the animal foot treading through would remain unimpaired.

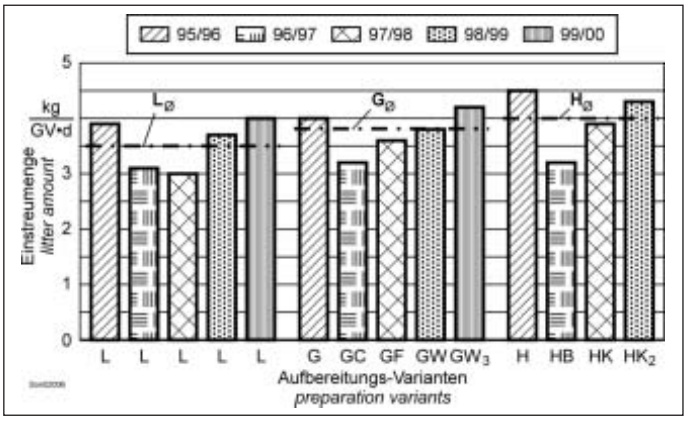

Fig. 3: Average litter requirements for heifers in deep litter housing, averages from the winter keeping periods from 1995/96 till 1999/2000 with the three differently processed litter variants $L_Ø$ = long (average of all long straw variants L), $G_Ø$ = minimally processed (average from balers with cutting device G, G...) and $H_Ø$ = intensively processed (average of all chopped or straw processed with litter implements variants H, H...)