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# Reducing Costs in Natural Fibre Processing

## Employing an Optimised Comb Shaker for Fibre Cleaning

*High-grade hemp and flax fibres are high in demand as raw materials, not only in the automobile industry. Experience in cultivation and harvesting, as well as modern processing facilities, are needed for European farmers to supply these raw fibre materials. A pilot installation has been developed at the Institute of Agricultural Engineering in Bornim with which both retted and unretted hemp, flax and linseed straw can be processed. Cost-effectiveness calculations and processing trials have shown that efficient fibre processing, and in particular efficient fibre cleaning, are necessary to be profitable for the farmer.*

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## Keywords

Hemp, fibre processing, -cleaning, comb shaker

## Literature

Literature references can be called up under LT 04501 via internet http://www.landwirtschaftsverlag.com/landtech/local/literatur.htm.

Now that cultivation is promoted by the EU, hemp and flax fibres have become established as high-grade locally produced raw materials for a variety of innovative products, e.g. in the building construction and automobile industries [1, 2]. Since questions concerning the cropping and harvesting of these fibre plants can largely be considered solved, the largest shortfalls at present are to be found in fibre processing [3, 4, 5, 6]. It will be necessary to solve the present process engineering problems connected with fibre production if a reliable value-added chain from cultivation, through fibre processing, up to the manufacturing industry is to be developed.

### Success factors for efficient fibre processing plants

Starting from an operating concept in line with the present state of the art and agricultural subsidy policies, the influence of various economic and technical factors on plant viability was examined in a sensitivity analysis. The variable factors in this analysis include market prices for fibre straw, fibres and hurds, personnel and operating costs, plant capacity and downtimes, as well as investment levels. The baseline data assumed for the model calculation included:

- straw throughput rate 2 t/h (DM hemp straw)
- fibre yield 25 % of weight, hurd yield 55 % of weight
- plant operation time availability 80 % as a minimum
- straw price 110 €/t (DM hemp straw)

The results shown in *Figure 1* reveal that the fibre yield, the fibre and straw prices and the plant operation time are of maximum economic importance. The 100% level reflects an annual pre-tax profit of approx. € 65000.

Besides increasing the throughput rate, raising the fibre yield appears to be one of the most promising options for securing profits, since in practice fibre yields are between 18 and 24 % and the straw throughout rate is less than 1.5 t/h DM. That is why there is an urgent need for efficient proces-

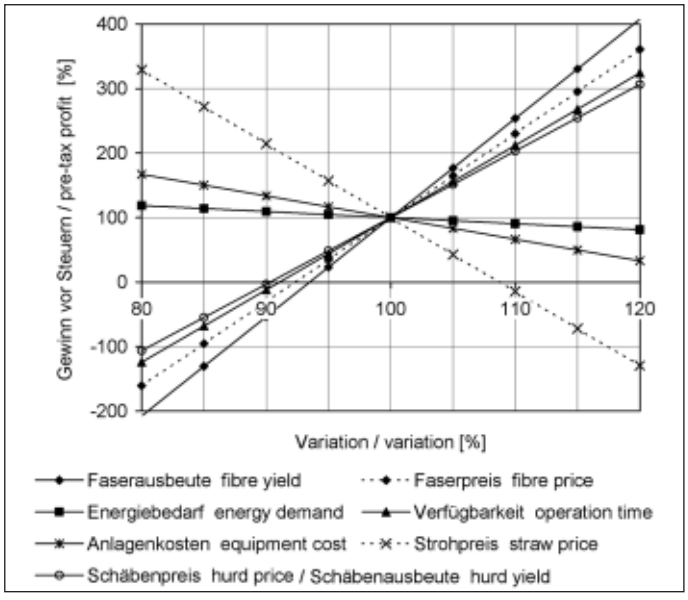


*Fig. 1: Factors influencing the operation result of a fibre processing plant (100% = 65000 p.a.)*

ses for fibre decortication and fibre cleaning that guarantee fault-free, fibre-conserving and low-loss fibre cleaning [7].

A promising plant concept is currently being studied in a pilot system at the Institute of Agricultural Engineering, Bornim. Operation under conditions geared to practice has shown that up to 3 t DM hemp straw per hour can be processed with this plant [8]. However, the bale opening or break-up and fibre cleaning must be modified to operate the entire plant at this performance level.

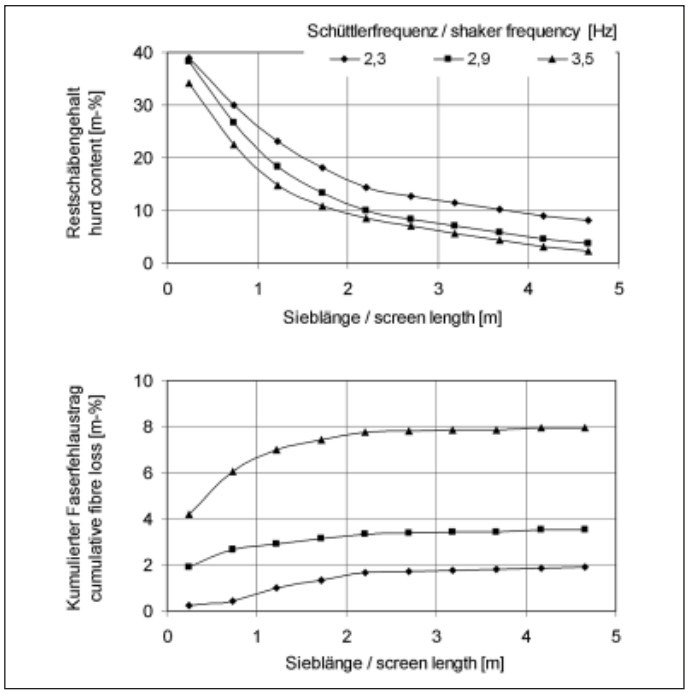


*Fig. 3: Hurd content and fibre loss versus screen length of comb shaker*

### Efficient fibre cleaning

The quality parameters determining the selling price such as fibre cleanness, fineness, length and dust content are set in the fibre cleaning stage following the straw processing. Up to 8-stage, cost-intensive cleaning lines, generally combinations of pedal and comb shakers, step cleaners and fine openers are used in current plants operating in practice [9, 10, 11]. These machines, whose working organs are very similar to the threshing, separation and cleaning facilities customarily used in combine harvesters, serve to separate the hurds (crushed wood constituents of the hemp stems) and the dust from the fibres and to refine the fibres. Despite the similarities in the cleaning technologies applied, corn-straw and fibre-hurd mixtures differ substantially in their screening behaviour. The hurds tend strongly to become caught in the fibre fluffs and the slight differences in density and floatation velocity call for improving of the processes used so far. The main burden of the cleaning operation is generally carried by screening machines - known as comb shakers or shaking machines (*Fig. 2*), which consist of a fixed screen grating with oscillating combs mounted above them as a screening and transport aid.

These low-cost machines have proved successful in classic long fibre cleaning, since they are characterised by a simple machine concept and good quality cleaning. It was necessary to review this system in order to implement the machine concept for modern short fibre production. That is why a trial shaker (comb shaker) was developed and tested for detailed study of the structural design under favourable operating and cleaning conditions [7].

### Test results

The test shaker can process a mass flow rate of up to 1.7 t/h fibre-hurd mixture with the adjustments carried out to date for tine kinematics and tine and screen geometry. This corresponds to a straw throughput rate of approx. 3 t/h DM for the entire facility [12]. When hemp fibres with an initial hurd content of 50†% by weight are cleaned, residual hurd contents of less than 5 % by weight are achieved at a screen length of 5 m (*Fig. 3*). The fibre loss under favourable operating conditions is approx. 3 % by weight (related to the total mass of fibres contained in the plant of 27 - 30 % by weight), so that the goal of a fibre yield of altogether 25 % is achieved.

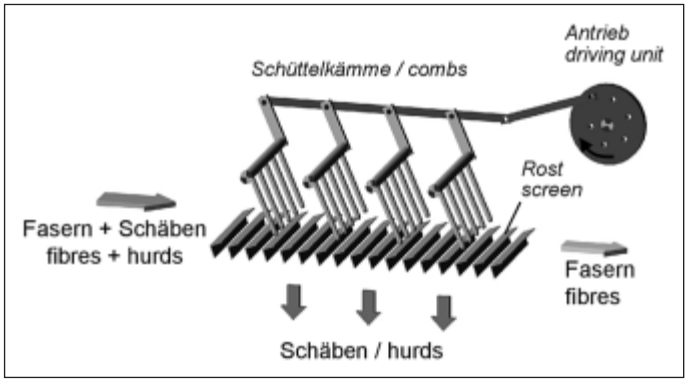


*Fig. 2: Comb shaker for natural fibre cleaning*

### Optimising the drive

In practice comb shakers are generally fabricated without any special mass compensation of the drive train. This leads on the one hand to elevated vibrations of the overall system that promotes good screening effects, while on the other hand it causes high downtimes and a shorter service life of the machine. Therefore a partial mass balance with a spring brake was examined in the experimental set-up. This made it possible to reduce the stresses on the drive train and the power intake by approx. 30 %.

### Summary

According to the preceding cost-effectiveness analysis, fibre cleaning represents a substantial cost factor and is a major obstacle to the throughput rate in fibre production. The test results obtained with a comb shaker used to clean hemp fibres have shown that this process can improve the throughput rate of the entire plant up to 3 t/h DM hemp straw. Residual hurd contents of approx. 5 % by weight at a fibre loss of only 3 % by weight can be achieved already after this single stage cleaning. Implementing these improvements in fibre production can also enhance the economic attractiveness of hemp cultivation for farmers and processing plants, even under the current conditions of reduced subsidies for hemp production.