

Compact Harvest Procedure

**Grain, straw, chaff ...,
and not yet reap it all.**

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Currently, there are two different types of development worldwide in regard to the cultivation and the harvest of threshing-crops.

First, the harvesting procedure and the harvester focused on harvest of grains have reached their limits in terms of machine dimensions and increasing the transportation capacities from field to grain storage.

On the other hand, there is an increasing demand in using agricultural residues for thermal purposes, biofuels, and fermentation or in recycling.

Thereby, the worldwide production of bio-based plastics has more than tripled during the last 3 years, and as forecasted, this trend will continue.

Such rapidly growing requests put the current focus on crop technologies as the basis of technological input costs. Neither the technical processes based on complex networked electronics nor the figurative “leaving-behind” of the biomass for subsequent processes is a sufficient approach.

The solution can only be seen in a consistent method change, which is aligned to the collection of any sustainably expendable plant components in a continuous process chain.

Compact harvest as a first approach

The proposal of the compact harvesting process is a conceptual approach. The current amount of unused and valuable material in chaff all over the country is at least 10 million tons. With the aim to use this material as well, the idea was born not to do onboard cleaning of grain and, instead of this, adding 25% of chopped straw to the grain flow passing the harvester. The predominating straw portion of 75% is consequently distributed in the field (see Fig. 1). On this occasion, the separate straw recovery by pressing line can be cancelled.

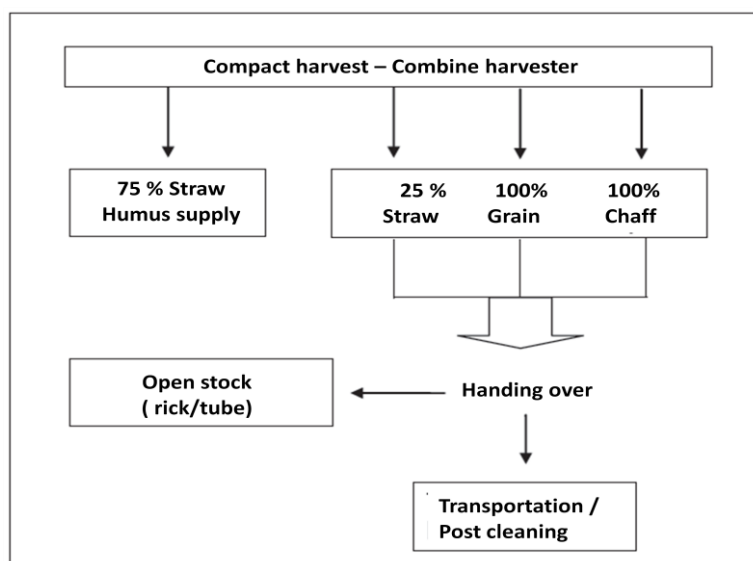


Fig. 1 - Material flow

This consequence is one of the main factors for a considerable and verifiable reduction of the over-all procedural costs.

A second effect is that a homogeneous mixture of grain, chopped straw, and chaff considerably compresses itself to permit the transport of the originating material volume with about 250 kg/m³ bulk density by a truck load of 25 t net.

Comparing this to the combine harvester / pressing-line by costs, it also reduces the expenses, although, with the additional chaff, the double amount in biomass is harvested as with the existing straw recovery.

For the practical person following effects are valuable benefits up to savings: only one crossing process of the compact harvester, better straw distribution by generally reduced amounts, lower grain losses, and additionally picking-up of weed seeds. Other advantages of it are the saving of re-operations and spraying agents.

The fact that straw and chaff must not be post-chopped for most purposes any more, results in pays-off not only for litter and distribution operations. So far the theoretical aspects of the procedure are described.

Status of implementation

The practical development occurred step by step from the "cake box" to technology. Initially, the different components of the cereal plant were mixed to get the feeling for volume, density and handling.

In 2012 the harvest was simulated by compact harvest mixtures in a plot combine harvester. With the use of a mobile device in 2013, the breakthrough to a real harvest process was succeeded (see Fig. 2).



Fig. 2 - Field test with device in 2013

Doing so, the desired final mixture could be generated in terms of produced unit tons, of transportation and of material stored in hoses (see Fig. 3).



Fig. 3 – Hose storage of harvest mixture

During these two years, about 30 big-bags could be provided for special research to some prospects all over the country, Austria and Switzerland.

Together with the company Novo-Tech GmbH in Aschersleben, e.g., it was possible to prove the suitability of straw and chaff for extrusion and use as decking boards (see Fig. 4). This is an extremely beneficial possibility of using agricultural biomasses in cascade systems.



Fig. 4 – Extruded decking boards out of straw / chaff mixture

Currently, two technical developments by partner companies on harvest chain are supported with approx. 20m³ mixtures from the harvest 2013: the mixture discharging from the collective bunker of the compact combine harvester and a highly competitive pre-cleaning for the recovery and marketing of the grain.

The first one becomes interesting also for normal transfer wagons and should be applied to discharge the hose storages as well. The second should be able to send transport units in the shortest time back to the process loop or to work efficiently as a mobile unit on hose storages.

Both could be practically tested this harvest year. The harvester prototype is also ready for testing based on collected experiences in 2013. Thus, the step from “cake box” to a recordable, evaluable, and applicable technology would be accomplished.

New opportunities and perspectives

These opportunities can only be hinted at here. However, they do inspire the adjustment of necessary activities very strongly.

Reduction of the procedural costs is confirmed

At first, the procedural costs comparison report worked out in collaboration with the University of Applied Sciences Schmalkalden which was already published in the German Farmer’s Magazine 33/2011 could be confirmed by an independent external post-calculation in 2013.

Profit for straw sales gets higher

As a result, it is unlikely as easy as ever to price the cost of straw harvesting in annual observations on the necessary bales revenues.

The current situation to obtain revenues of 100 €/t giving away 80 €/t as an income to third parties and sharing the rest 20 €/t with the tax office simply does the farmer exclude from the value chain (own interpretation of the data by SCHINDLER, German Agricultural Magazine [dlz], July 2013, p 117).

The generation of higher bale densities as well as other similar measures will be of little help. Where straw is needed in large quantities very sensitive processes are behind. Even for heating plants with 1,000 t annual requirements a maximum of 120 kg/m³ are allowed by contract because of possible failures in bale breaking. The relevant data of the compact harvesting method compared to the costs by SCHINDLER’s summary (Fig. 5), shows which financial potential unfolds for farmers at marketable prices. Not considered yet are the additionally possible revenues out of chaff by using more biomass at the same cost advantages.

Costs in €/t	SCHINDLER	Compact harvest
Nutrient value	23,89	12,00 ¹⁾
Compacting straw	13,73	7,00 ²⁾
Loading straw bales	- telescopic loader	-
	- tractor and trailer	-
Transport 5 km	8,02	6,00 ³⁾
Unloading	3,90	-
Pre-cleaning	-	1,00 ⁴⁾
Storage	- storehouse	8,00 ⁵⁾
	6 months - field's edge	16,26

Fig. 5 - Cost comparison straw harvesting with SCHINDLER’s basic data (dlz, July 2013, p 117)

- 1) Max. 50% estimated due to 30% of biomass removal only,
- 2) Stationary at cleaning, electric drive
- 3) Average value of Association for Technology and Structures in Agriculture (KTBL), such as grain transport
- 4) Estimation, conservative
- 5) Mixture including grain in hose, analogous silage x factor 1.2

Chaff not only monetary income

The taking along of chaff may evolve into the first phytosanitary measure before the new sowing. For example, the weed seeds that are contained in the chaff offer opportunities for problem solving, which currently reaches its limits both physically and chemically. The effective reduction of herbicides and also looming phytosanitary aspects are therefore subject areas for further research and development needs.

High pressing densities in the hose method inspire

What a surprise was depositing the mixture based on the technology of the company Budissa Agro Service GmbH in hose stock with a pressing unit customarily used for silage. Achieving a predictable compressed density of 550 kg/m³ allows it to temporarily store a complete harvest hectare mixed with 8 tons of grain and 1.5 tons of straw and chaff in 2 m hose near the field. This can be done near to the biogas plants as well as on farmyards in a very economic and safe way. Furthermore, it serves to stretch the harvest window and to customize processes and delivery. Three facts are particularly noteworthy because they speak for the future of the technology:

- Comparing to individual storage of grain and straw of similar quantities, the compact crop mixture in the hose needs over 25% less storage volume. In this case, the hose is “not modified shelter” of first quality. Predictable storage and warehousing costs of about 8 € / t for the mixture underline these advantages (Fig. 5).
- Only the fraction straw / chaff pressed with 200 kg / m³ (current test) represents an endless bale of very high compression density, whose handling could prove to be very effective for many processes.
- The hose designed to silage is a clean-room system! Therefore, it makes sense to explore beyond the harmless temporary storage the possibilities of a preliminary material stage in terms of planned end products. A hose drying would be an obvious way. First experiments with a special approach are running. Such facts do inspire to think about mobile, flexible, efficient and thus more cost-reducing technologies in the overall process.

Also re-work the new combine harvester

The combine design is dictated by the fact of grain losses in its technical execution up to constructional details of all components. The elimination of cleaning stage and other sources of loss as well as the already central post-treatment of the crop mixture enable the compact harvester not only rearrange but for a long time to re-think it for the first time. This could have a performance enhancing and simplifying effect. This is an aspect that was ostensibly not yet stressed. It paves the way for new developments done by agricultural engineering designers. In addition to the University of Schmalkalden which has supported both technological issues and design details from the early beginning, it was possible to simulate the interest of the department of industrial design at the Otto-von-Guericke University Magdeburg.

Summary

„Grain, straw, chaff ..., and not yet reap it all” stands for:

- A current social development with the goal of developing all the available natural resources;
- The commandment to do so environmentally safe, socially and not only economically sustainable;
- The idea of a harvesting procedure designed to implement this policy and rule for the strongest technical and technological potential of combine harvested crops in future.

For this process theoretical advantages have been described and calculated very early.

The harvested crop mixture volume became a thinking barrier that cannot be overcome so quickly. This describes the exclamation of a seed cleaning plant manager at the sight of the mixture probably best: "You did it surely not intentionally!" Since then, the basis for the implementation of crop trials under practical conditions was created in a variety of analyzes and experiments in 2013 by very dedicated partners in institutions and working farms. Thus, the evidence was provided:

- That the initial objectives and advantages of the method are available,
- That the bulky crop mixture may be efficiently harvested, transported, and stored at high machine throughput,
- That in fact it can cause surprising effects to further technological variants,
- That original objectives have the potential for new dimensions such as the consequent pick-up of chaff in terms of phytosanitary and herbicidal effects.

In fruit season 2014, a harvesting method on wheels will be used. It was already published in the 2/2012 issue of the Journal NEW AGRICULTURE (section future ideas).

This development up to structural and design implementations is accompanied not only by scientific institutions. It also arouses the increasing interest of enterprises that have been sensitized from the start of the new product straw / chaff and its material and economic potential. It represents a market within the farmer could get a share applying this harvesting method.

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Straw chaff > 200 kg / m³ press density



Pre-cleaning <0.1% "grain loss"



"Kernel Star" brings 16% more biogas