



Spreading of chaff and straw on combines



The Combi system

A new concept developed by Rekordverken Sweden AB

Resulting in:

High flexibility

High efficiency

Low energy requirement

Low environmental impact

Higher demand on husk treatment

The development during recent years within agricultural have put higher demands on the straw chopper and chaff spreader for combines. The main reasons for the increased interest in the function of husks treatment are that:

- Larger combines have a higher flow of straw and chaff
- Wider combines have a demand of better spreading widths
- More intensive straw processing in the combine results in more chaff and straw residues from the sieves
- Reduced cultivation have a higher demand for an even distribution of husks
- Breeding and spraying have resulted in tougher straw and then more leaf residues on the sieves.
- Spraying of couch-grass is not possible in the chaff row behind the combine
- Weed seeds and waste grain are concentrated behind the combine



The Combi system - A revolution in chaff and straw handling

A totally new concept for handling of chaff and straw on combines has been developed by the Record Company. This patented concept is called the Combi system. The system makes it possible to distribute the straw and chaff separately or handle them together. It is made possible since the chaff spreader can be regulated to throw the

material to the sides or to the back into the chopper (figure 1 and figure 4). The handling of husk from the combine may then be optimised depending on the choice of following crops and the utilisation of the residues. The system is flexible with different settings, which easily can be selected.

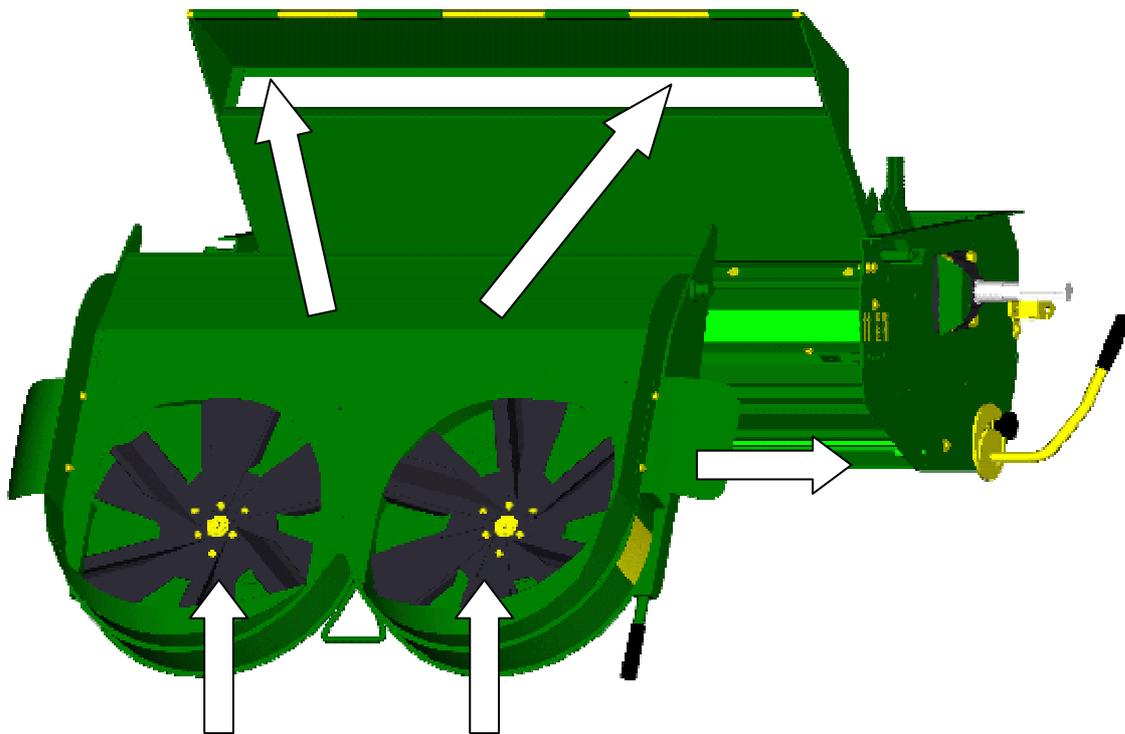


Figure 1. The chaff spreader, where the right half demonstrate the system when spreading the chaff and the left half when the chaff is distributed together with straw through the chopper.

Possibilities with the Combi system:

- To adapt the spreading of chaff, separate or together with straw, due to the circumstances of the crop for optimal result
- To optimise the spreading of chaff and straw separate
- To reduce the load on the chopper by separate spreading of the chaff
- To reduce the wear and energy consumption, by shutting of the chopper when straw is collected and chaff is spread separate.
- To get higher yield, density and feed quality of the collected material by including chaff in the material to be baled.

The importance of proper handling of chaff and straw

Benefits of chaff and straw

Cereal straw has a wide field of application. Earlier, the straw was often fired in the fields in order to reduce problems in the following crops. However, it is now increasingly regarded as an important resource, e.g. for use as fuel in district heating plants, or as a fodder or for livestock bedding.

Furthermore, as the husks contain a large proportion of slowly degradable organic matter, it is a resource also when left in the field, since an increase in the carbon content in soils will result in improved water and nutrient holding capacities. The carbon content is especially important in soils with poor structure.

If the husk is to be used for energy, as much as possible should be collected. An ability to also collect the residues from the sieves, in addition to the straw, is then an advantage. This is also advantageous when using the husks as fodder. However, when it will be used as bedding the chaff will result in increased working environment problems through dust. It may also be a health risk for animals, when used for e.g. horses.

In the normal situation the harvesting residues are left in the field. It is then of great importance with an even distribution of these residues on the ground. The importance of a proper function of the distribution equipment is increasing primarily because of the increasing harvesting yields and wider combine harvesters. A smooth distribution of residues will result in faster degradation, more even supply of nutrients, and less problems with tillage and drilling in the following crops.

Problems with chaff and straw

An uneven distribution of straw and chaff result in three types of problems:

1. Uneven degradation ratio and nutrient availability,
2. Difficulties in following tillage and drilling
3. Difficulties with weed control

Degradation ratio and nutrient availability

Straw has a high carbon/nitrogen ratio, i.e. a high content of carbon in comparison with the content of nitrogen. Therefore, when straw is degraded forming micro-organism and humus with lower carbon/nitrogen ratios, nitrogen is consumed. The quantity of nitrogen available for crop growth is then reduced. However, this has a positive effect since it reduces the risk of nitrogen losses in autumn when the precipitation is high. Thus, an even distribution of residues will minimise nitrogen losses and result in an even availability of nutrients for the crops in the field.

Table 1. Content of nutrients in straw from different crops, kg/tonnes (Hammar et. al., 1990)

	Nutrient content		
	N	P	K
Cereals	5	1	8-10
Oilseed	12-15	2	25-30
Peas	10	1,3	2

Since the straw and husks also contain other nutrients, e.g. phosphorus, potassium and sulphur, a more even distribution of these nutrients will be obtained (table 1). Field studies have confirmed that the distribution of husks behind the combine may be very unequal. An example of how this will influence the distribution of nitrogen from plant residues is presented in figure 2.

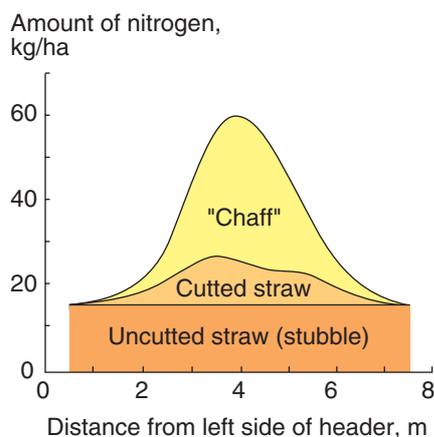


Figure 2. Average distribution of nitrogen from wheat harvesting with an ordinary Gleaner combine with 6,1 m width and 40 cm stubble height (Douglas et. al., 1992).

Difficulties in tillage and drilling

A properly chopped and distributed straw residue reduces the risk of operational disturbances in the tillage of the following crops. Moreover, short straw will more easily be

mixed with the soil, which facilitates degradation (table 2). This is of primary importance in direct seeding, or other cultivation systems with reduced tillage. Evenly distributed straw and chaff is also essential to avoid disturbances in the growth of the following crops. Furthermore, incomplete mixing of straw in soil may be a source for foot rot diseases of cereals.

Table 2. Vertical distribution of straw with different straw length as the result of mixing with rotary cultivator (Tebrügge & Griebel, 1990)

Depth	Straw length		
	40 mm	80 mm	160 mm
Soil surface	10 %	15 %	20 %
0-50 mm	40 %	50 %	60 %
50-100 mm	50 %	35 %	20 %

Tebrügge & Griebel (1990) concluded that chopping of straw as much as possible should result in particles in the range of 3-8 cm, and that the length of both the stubble and straw should not increase 15 cm.

Difficulties in weed control

Uneven distribution of husk may result in difficulties with weed control. Layers of residues where the weed is not growing through makes spraying less efficient. Thus, the function of the distribution system for straw and chaff is also of vital importance for the weed control.

Benefits with the Combi system

The patented chaff spreader

The adjustment of the chaff spreader is simple by changing the location of the discharge from plates (figure 1). Depending on model a shutter can be rotated or lids opened to regulate whether the chaff will be spread separately or mixed with the straw. The plates are then distributing the chaff either sideways out on the ground or backwards into the chopper, where the chaff is mixed with straw.

The construction with turning plates is reliable. Their combination of throwing and fan effect, results in a high spreading width together with a low power demand. A chopper located furthest back to reduce disturbances involves no problem due to the good throwing characteristics. The chaff spreader is powered by a hydraulic system or belt driven.

The new straw chopper

A new chopper has also been developed with a higher capacity, better spreading performance and finer chopping, without an increase in energy demand. This is achieved by a unique construction with 8 rows of knives, and also more knives that together with the design of the chopper shell give an almost constant load and an excellent air flow (figure 3). The high capacity and even makes the chopper and combine running with a high efficiency without problems.



Figure 3. The new straw chopper equipped with 8 rows of knives.

Optimal function with total flexibility

There are four combinations of settings for the chaff spreader and chopper (figure 4). Settings to be choose may depend on how the residues will be used and the following crop. Furthermore, the farmer has the freedom to choose what he thinks to be the best configuration. The different settings have different advantages.

1. Straw is collected in a windrow. No chaff in the windrow results in a less dusty straw, which improves its characteristics as a bedding material. The chopper is shut off, which also reduces the wear and energy consumption on the combine.
2. The chaff is spread separate to the straw which is chopped and spread. With this alternative, the setting of chaff and straw handling equipment can be made separately. Moreover, the chaff will not put any extra load on the chopper.
3. The chaff is directed into the straw and windrow together with it. The amount of material collectable for use as fuel for heat production or bedding increases when the material from the sieves included. Furthermore, possible problems from chaff, weed seed and spilled grain, when left on the ground, are partly avoided.
4. The chaff is thrown into the chopper and chopped and spread together with the straw. The chopper blows the straw and chaff into the stubble, reducing the dust around the combine. Reduction of the dust improves working environment and also diminishes problems with, e.g. the air cleaner on the combine.

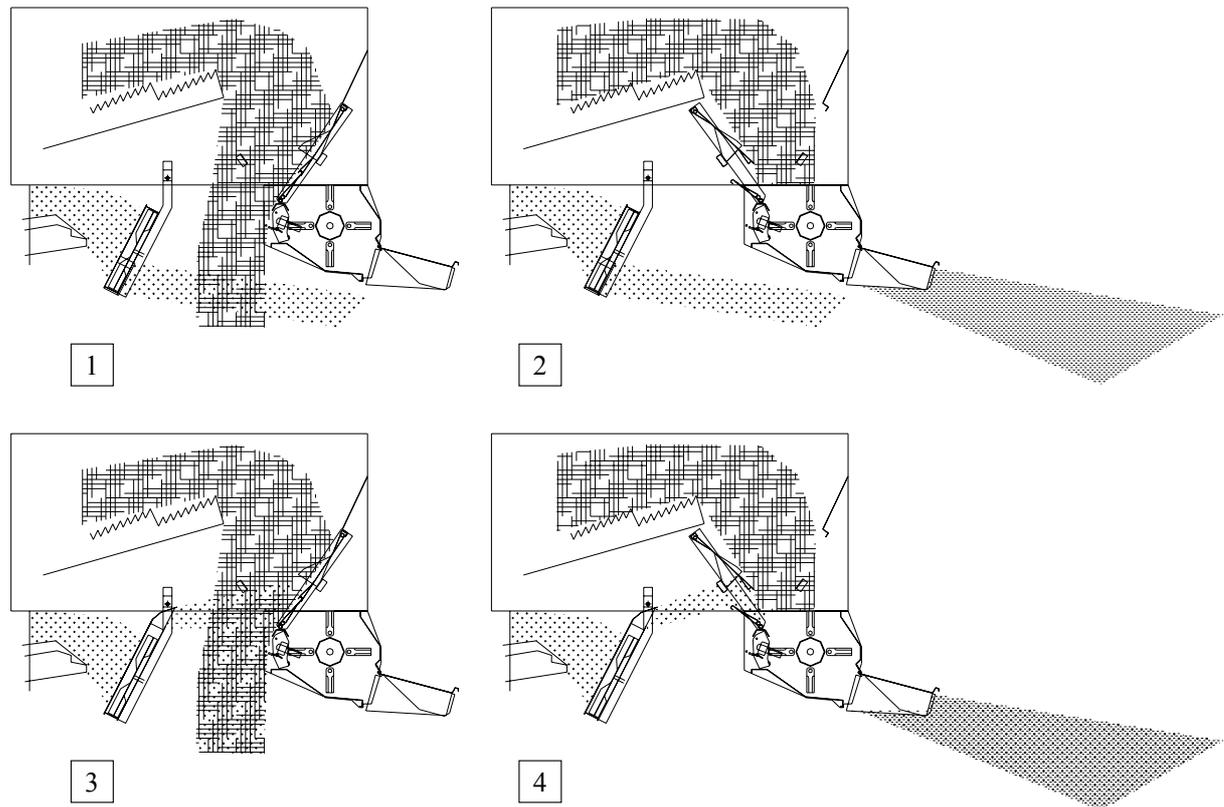


Figure 4. The different alternative settings of the Combi system: 1) the chaff is spread separately an the straw is collected in a windrow, 2) the chaff is spread separately to the straw which is chopped and spread, 3) the chaff is directed into the straw and windrowed together, 4) the chaff is thrown into the chopper and chopped and spread together.

Comprehensive tests

The patented Combi system has been developed during the last two years. Intensive testing of the construction has been carried out in Europe, South America and in Australia. The Combi system has then been mounted on several types of combine harvesters from different manufacturers. The tests have shown good results with excellent spreading evenness, low power demand and a high reliability.

References

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Rekordverken Sweden AB
Öttum, S-535 92 KVÄNUM, Sweden
Tel. +46 511-303 00 · Fax: +46 511-303 01

<http://www.rekordverken.se>