

4. Handling of Straw



photo: lars nikolaisen

The loader tractor ready to load the truck and trailer up with 24 big bales. In this case, the bales are transported directly to Grenaa Kraftvarmeværk (CHP plant) where they are unloaded, 12 bales at a time, by an automatic crane.

Large-scale straw handling for energy purposes has developed into an independent discipline in agriculture with attachments in which particularly large farms and machine pools invest.

After combine harvesting, the straw is left on the earth in swaths. The straw should be removed as quickly as possible so that the treatment of the soil preparation can begin thereby establishing next year's crop. The thickness of the straw swath has increased considerably over the recent years, because the combine harvester swath width has been considerably increased. This is an immediate advantage in respect of the baling capacity, but it may be problematic to dry the straw after rainfall.

The following calculation is based on a straw yield of 3 tonnes per ha, a field size of 4 ha, and a transport distance of 1,000 m from the field to the farmer's storage. Big bales are currently delivered from the storage to district heating plants etc. during the year depending on crop delivery contracts. Straw that has not been baled into big bales is used primarily in the farmer's farm-scale boiler.

Baling/Chaff cutting of Straw

The following baling/chaff cutters are examples of baling/cutting types used in agriculture:

- Small baler
- Round baler
- Medium-size baler
- Big baler
- Chaff cutter

The *small baler* typically has a tunnel dimension of 46 x 36 cm and a bale length of 80 cm. The weight of the bale is approx. 12 kg, and the bale density is 90-100 kg/m³ /ref. 17/. Previously, it was the most widely used type of baler, but is now used only to a small extent for baling of straw for bedding and for burning in small farm-scale boilers.

The *round baler* has been in the market for approx. 25 years. The commonest type of baler bales into a width of 120 cm and a diameter of 150

cm. The average bale weight is 244 kg, and the bale density is approx. 110 kg/m³ /ref. 17/. There is also a type of baler designed for round bales of 150 cm width and 180 cm diameter. That was the type that was first marketed, but now it is only seldom seen. The interest for the round baler was great when it was marketed, but has declined over the last many years. The round baler is primarily used for baling of straw for feeding and bedding purposes, and for burning in straw-fired farm-scale boilers.

The *medium-size baler* has gained a firm foothold in agriculture for the baling of straw for feeding and bedding purposes, and for burning in farm-scale boilers. It was marketed some years after the big baler, probably because the bale dimension is more suitable for agricultural purposes. The baler tunnel dimension is typically 80 x 80 cm and the bale length is 240 cm. The weight of the bale is approx. 235 kg, and the density is approx. 140 kg/m³. However, balers with other tunnel dimensions and bale lengths from 120 to 200 cm are also manufactured. The baler often is equipped with a chaff cutter, thereby increasing the bale density to approx. 165 kg/m³. Chaffed straw is a better bedding material, and this is the major reason why the baler is equipped with a chaff cutter.

The *big baler* has been in the market for approx. 20 years. It is the only bale size that is accepted by the district heating-, CHP-, and power

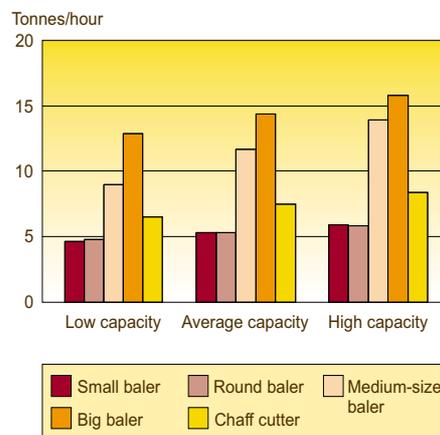


Figure 9: Gross capacity by baling or chaff cutting of straw.



photo: bygholm

A self-propelled chaff cutter blows the straw up on to vehicles that transport it directly to storage.

plants. The baler tunnel dimension is approx. 120 x 130 cm, and the bale length is approx. 240 cm/ref. 18/. The bale length may however be adjusted from 110 to 275 cm, but for reasons of road transport, a bale length of approx. 240 cm is most suitable. The bale density has increased over the years due to the technological development of the baler. The average bale density is 139 kg/m³, and the average weight of bale is 523 kg/ref. 18/. The introduction of other baler types that conform to a width of 120 cm and a length of 240 cm, which is the most important requirements by the plants, has been tried. These balers produce a bale height of less than 130 cm. They can be equipped with a chaff cutter which means that the bale density may be increased to approx. 170 kg/m³/ref. 18/. However, these baler types have not gained ground and are therefore not widely used. The baler is used primarily for baling of straw for heating-, CHP-, and power plants and for large farm-scale boilers.

Chaff cutting of straw for the use at heating-, CHP-, and power plants in bulk (without having been baled) has been tried, but it requires a reconstruction of receptacle and feeding facilities of the plants. The storage facilities on the farms also should undergo adjustments, since storage in the field without cover causes losses and decrease in value/ref. 20 and 21/.

For the chaff cutting of straw from the field a towed or self-propelled chaff cutter and a cutter loader may be used. The cutter loader is equip-

ped with a chaff cutter, and the system thus makes out an all-in-one unit that both cuts, transports and unloads the straw /ref. 17/. By using a chaff cutter, a suitable number of trailers can be used for the further transport of the chaffed straw to the destination. One of the greatest problems connected with chaffed straw is though that the volume weight by transporting is very low, i.e., 45-50 kg/m³ /ref. 20 and 21/. However, by storage by loader tractor or straw blower with adjuster fan, the volume weight is 70-80 kg/m³, though.

The *baling capacity* depends on the choice of technology which Figure 9 clearly illustrates. The gross capacity that includes all operations in connection with the baling is lowest when the straw is baled by a small baler and round baler, and it is highest when using a big baler /ref. 19/.

The chaff cutter capacity (self-propelled) is considerably higher than that of the round baler, but also lower than that of the big baler. The capacity of the newest and largest self-propelled chaff cutters is considerably higher than stated here.

Transporting Straw to Storage

When transporting straw, various techniques and methods are used depending on the local conditions.

Small bales are loaded in the field by hand, bale fork, bale loader, bale chute, or bale gun. Back on the farm, the bales are unloaded by hand directly into the storage or an elevator or bale conveyor. The bales can also be dumped and then by hand placed on an elevator or bale conveyor. If an elevator is used, the bales shall be stacked by hand, and if a bale conveyor is used, it can partly distribute the bales in the storage. The bale conveyor is particularly fitted for lofts. Flat cars or special V-shaped straw vehicles are used. They will contain from 75 to 250 straw bales /ref. 17/.

Round bales are loaded by front-end loader, loader tractor, trencher or the like. The same machinery is used



photo: bygholm

The bales are fastened with straps, thereby securing that the load reaches the farm or the plant safely.

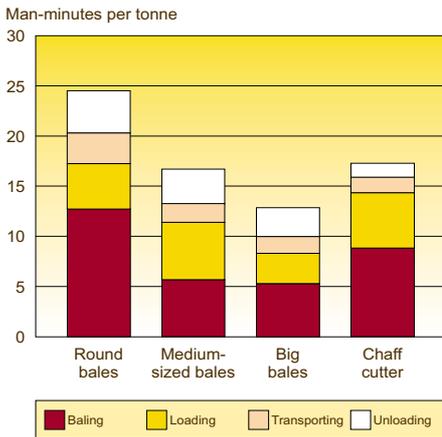


Figure 10: Manpower required for pressing/chaff cutting of straw and transporting to storage.

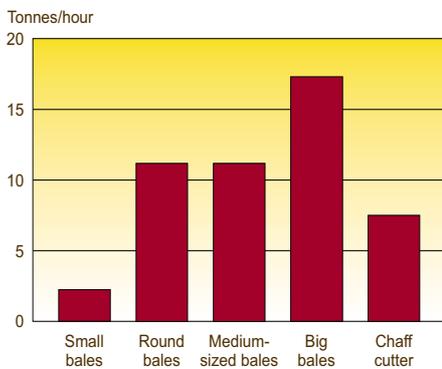


Figure 11: Capacity during transporting of straw to storage.

for unloading in the storage. The front-end loader is the most used machine both in field and in storage. Depending on the front-end loader design, lifting capacity, and the local conditions, one or two bales are handled at a time. Most often, only one bale is handled at a time. For transport, reconstructed trucks or truck trailers are used, but also ordinary farm trailers or specially designed vehicles are used. Usually, the tractor is only towing one trailer, and it will contain from 8 to 14 bales /ref. 17/.

Medium-sized bales are loaded and unloaded by front-end loader, trencher, loader tractor or the like. The front-end loader is the most used machine for both loading in the field and for unloading in the storage or at the straw stack. One or two bales are handled at a time depending on the front-end loader equipment and lifting capacity. Reconstructed trucks, truck trailers, flat cars, or specially designed vehicles are used for the transport. The size of the loads varies from 12 to 45 bales, but most often load will hold approx. 24 bales.

Big bales are loaded and unloaded by front-end loader, trencher, loader tractor, telescope loader or the like. The telescope loader is suitable for unloading, because it can reach high up when storing in stacks. The front-end loader is the commonest. Depending on the front-end loader equipment and lifting capacity, the tractor load capacity and stability, and the local conditions, one or two bales are handled at a time. The capacity is highest, when handling two bales at a time, but it is a severe load on the tractor front axle, and the stability of the tractor is decreased dramatically if not a balancing weight is mounted on the back of the tractor.

Reconstructed trucks or truck trailers are widely used. The size of the load varies from 6 to 18 bales. Over long distances, the tractor is often towing two trailers so that the size of the truckload attains 24 bales per trail /ref. 17 and 19/.

Manpower Required

The manpower required for the baling and transport of the straw to the storage on the farm varies with the type of bale and technique that is used during loading, unloading, and transport. The

manpower required for the handling of small bales is thus 72 minutes per tonne when loading unloading by hand. This is almost 3 times as much as required for the handling of round bales and 5½ times more than required for the handling of big bales, see Figure 10. By mounting a bale chute on the bailer and by loading directly on to the transporting vehicle, the manpower may be reduced, though, to approx. 45 minutes per tonne for small bales.

The manpower required for chaff cutting of the straw or for the handling of medium-sized bales is the same, i.e., 17 minutes per tonne. By handling of big bales, the manpower required is only 13 minutes per tonne, though. This very drastic reduction of the manpower required and the great physical labour saving is the principal cause of small bales having been almost outdistanced by round bales, medium-sized bales, and big bales.

Delivery to Plant

During the heating season, the straw is usually delivered to the plant in accordance with a crop delivery contract. It may be a direct agreement with the farmer, an association of



Straw left in swaths in the field where it is baled into bales of a weight of above 500 kg by the big baler.

photo: sønderjyllands højspejdingsværk



photo: bygholm

A tractor with front-end loader places 2 big bales on the tractor trail at a time. The vehicle in front is a reconstructed truck body from an old truck. If the front-end loader has to wait in the field while the straw is taken home, the waiting time is used for collecting the bales into stacks that are equal to the number of bales the tractor trail will contain .

straw producers, or a contractor. This agreement includes, e.g., delivery dates, quantities to be supplied, contracted prices, and quality criteria. By farmer transport, either a tractor or a truck is used. The farmer loads and transports the straw to the plant, and the plant personnel unloads it either by forklift truck, overhead travelling crane or the like. When transporting by haulage contractor, the farmer or the haulage contractor loads the truck, the haulage contractor travels to the plant where the plant personnel unloads by forklift truck, overhead travelling crane or the like. In certain cases, there are sometimes more people involved in haulage by contractor than in transporting by the farmer which may result in waiting time for some persons, e.g., the driver. The driver often uses part of the waiting time for mounting or dismounting straps around the load. By transporting by tractor, the rate of speed is considerably lower than that required by haulage by haulage contractor, and conse-

quently the capacity is lower. Figures 12 and 13 show the manpower required and the capacity when delivering big bales to the plant /ref. 19/. The figures clearly show that the manpower requirement increases, and the capacity decreases with increasing transport distance. It is also obvious that the manpower required is greater and the capacity lower when transporting by tractor than by haulage contractor, and that the differences increase with increasing transport distance.

When transporting by truck, there are almost always loaded 12 bales on the truck and 12 bales on the truck trailer distributed in two layers. This is also seen by tractor transport, but load sizes of 16 or 20 bales is widely used, particularly for transport over short distances.

Plants unloading by crane, often require that the bales are arrangement accurately on the vehicles, and that the bales should have a specified dimension and not exceed a certain

weight. In connection with the delivery, only big bales have been mentioned, because the plants are upgraded for this size of bales and handling technique. At a long view, also other methods ought to be analysed and large-scale tested, like e.g. straw pellets, whose volume weight is much higher.

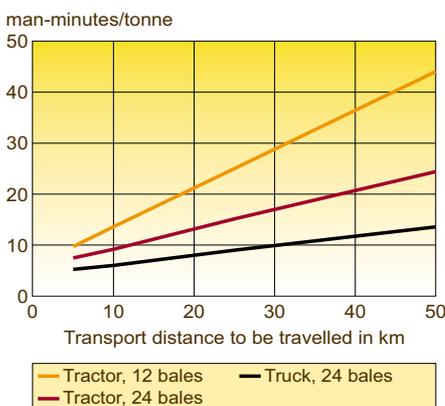


Figure 12: Manpower required for the delivery of big bales.

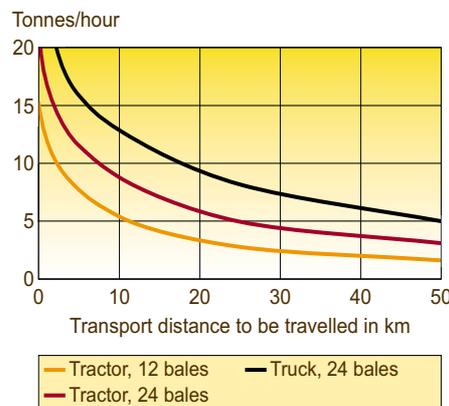


Figure 13: Capacity at the delivery of big bales.