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Trends in the building of cereal storage facilities

According to the BML the production value of cereals in German agriculture is 6,784 million DM which equals about a quarter of the total crop production value. With this standard of importance, it is appropriate that work on further development in drying and storage of grain continues. Reviews made in practical farming, but also at specialist farming shows and company conferences, point to new constructional trends stemming from the cost-pressures on farmers in general.

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Keywords

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Literature

Books are identified by •

[1] *Keiser von, H.*: Lagerbelüftungstrocknung. RKL-Heft Nr. 4.3.1.0 (1999), S. 1024-1098

[2] • *Damm, Th.* (Hrsg.): Handbuch landwirtschaftliche Betriebsgebäude. Heinze-Verlag, Celle, 1997

The utilisation of harvested grain – on the farm, for sale or seed multiplication – determines the demands on the storage and conservation of the material.

Farm rationalisations in the last years have led to expansion in the area down to grain and breeding successes and production-technological advances to increasing yield per hectare. In grain harvesting, large machines are increasingly used. The harvesting performance increases, fair weather windows can be better exploited. As a result:

- The present storage area on the farm may be too small.
- The capacity of grain reception does not match the high output of big machinery.
- A greater choice of systems in grain storage and conservation is possible because of the lower moisture content resulting from faster harvesting capabilities.

Simple grain storage

The space requirement and storage weight of grain is dependent on the moisture content, sample weight, and possibly the amount of straw, chaff, etc., too. Applying as an acceptably accurate estimation method for the calculation of capacity is:

$$g = 0.8 \text{ Mp/m}^3 \quad (1)$$

$$\text{Storage space} = 1.5 \text{ m}^3\text{/Mp.} \quad (2)$$

The heat conductivity in the grain pile is regarded as limited, which indicates a good temperature-insulation property.

The simplest possibility for grain storage is offered by the horizontal store. For this, a concrete floor plate is first formed. The side walls can be concreted, but a cheaper solution features a welded framework of 'L' steel girders supporting wooden planks. The ground flange of the elements is pressed downwards by the weight of the grain and therefore the sides are very stable. This applies to the forewalls too. A "Building programme from agricultural engineering Weihenstephan" contains a list of suggestions with measurements of the most important parts of such horizontal stores, which also are very suitable for building with farm-labour.

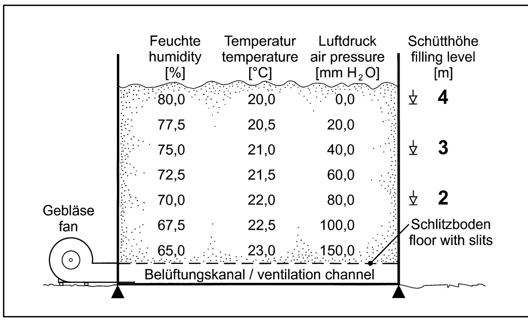


Fig. 1: Course of moisture and temperature in the grain stack acc. to [1]

Drying and storing

Because grain has, as a rule, a moisture content of 17% or more at harvest and long term storage is only possible at 15% or less, on-farm grain storage facilities mostly include grain drying capacity.

Taking a 4 m high pile of grain, [1] has presented as an example what kind of changes in the air temperature and moisture need to be made for a wheat batch with 18% natural moisture by a 50 m^3 airflow (*fig. 1*). The air pressure at an assumed 100 mm water column above the ventilation canal can be reduced down to 0 by the time it reaches the top of the pile which indicates an optimum exploitation of air pressure. At the same time the temperature of +23 °C in the area of the air canal is only reduced to +20 °C in the upper layer. The respective air moisture range runs from 65% at the canal to 85% above.

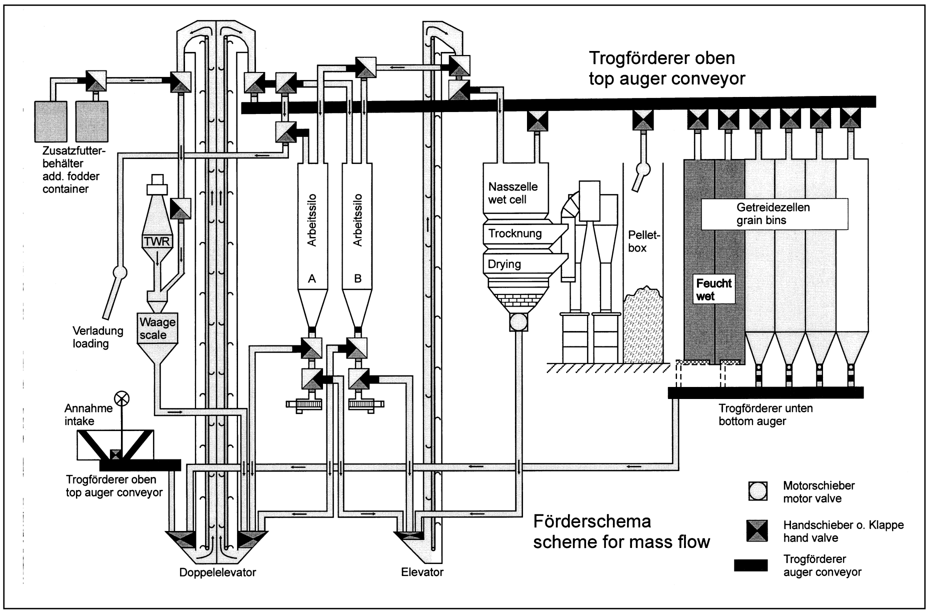
The required components for the on-farm grain drying and storage facility are:

- Grain reception point
- Grain conveyance (per gravity, air pressure or auger)
- Cleaning (per fan cyclone)
- Drying
- Storage
- Where feed has to be prepared: milling and mixing plant.

The aforementioned components represent a complex plant, the pieces of which must be complementary. The technical demands must be according to the target for the grain.

The grain reception point usually consists of a cemented wedge-shaped inlet into the ground which is covered by a raisable steel-girder grating. In that today's transport vehicles are very heavy with weights of up to 40 t, the dimensions of the plant components in this case have to be appropriate. In the be-

Fig. 2: Drying and storage of grain in the FAL test station



low-ground grain inlet point is situated an auger. The reception point also serves as a storage buffer between the transport trailers and the end storage.

In order to link the system together, ways of conveying grain between the individual components of the plant are necessary. These can be simply drop pipes, but mainly comprise conveyor belts, elevators (single or double), augers, pressure or vacuum air transport systems, chain driven lifters or chain and flight transporters. Removal augers which are positioned laterally to the longitudinal conveyors are also.

Next step is the cleaning of the freshly delivered grain through a cyclone and sieves in at least two stages. At this point, it is also possible to sieve the grain according to size – an exercise required for malting barley. The cleaning step also helps to make drying and storing the grain more efficient and secure.

To the minimal on-farm equipment belongs a pre-cleaner. With this, so-called “light material” is separated from the grain. In the actual sieve cleaner, sieves with different mesh sizes can be fitted. It is very important for a secure working of the plant that apparatus for keeping the sieve surface clean is included. This can comprise brush cleaners or can also be ball-sieve-cleaners.

For special purposes in the separation of grain the following properties can be taken advantage of: density of corn, its surface characteristics and elasticity. Here, belt dressers, magnetic cleaners, swing-rope table dressers and air pressure graders are available. These plant components are, however, seldom required.

Heart of the plant is the drier. Herein lies the complete technical know-how of the supplier. The technical dimensions of the plant are drawn from the calculation of the so-called required moisture withdrawal (F) in kg/dt of undried material (U) according to the formula

(Formel einsetzen) (3)

The representation of the more detailed calculation and lists regarding heat requirements, the drier rated performance and the measuring of the hot air drier can be found, in addition to rough calculations over energy requirements, in [2].

Depending on the technical design of the plant, several types of drier come into consideration:

- Batch drier
- Circulating drier
- Continuous drier
- Trailer drying
- Double-shaft circulatory drier
- Flat try drier
- In-store drier

Constructed for the actual storage:

- Roof or ground supported horizontal stores
- Horizontal stores with combined air flow and emptying systems
- Hoppers/vertical silos.

With every plan for a storage container the first task is the calculation of the required storage space. In [2] one can find a table with the required volume weights in m^3/ha for different harvest amounts in dt/ha; in-between values can be easily interpolated for.

An particularly typical plant for drying and storage of grain was built in the 70s at the research station of the Federal Research Institute for Agriculture in Brunswick, and this is still working unchanged even today.

Figure 2 shows its flow design, from which it is plain that much experience is required for the optimum (i.e. with minimum energy and time input) operation of such a plant.

However, there’s now a case for adjusting this plant to cope with the increasing amounts (concentration) of grain. This is possible through two strategies: The insertion of other stores in-between and/or the increasing of throughput through technical actions such as increasing the size of the fans. There are ,however, limits to such actions nowadays.

Outlook

The further path of developments could be seen at the last Agritechnica in Hanover. Here, the plants were in principal larger and at the same time technically simpler. This was achieved through desisting with “topping up” during drying. Thus, the problem caused by this – the handling of high moisture content grain in higher batches of grain – could be solved through using hanging augers, driven from above, working in the pile as stirrers.

Such a plant originating in America is illustrated cross-sectionally in *figure 3*. The US market leaders DMC (David Marketing Company) from Iowa also offer to convert existing silos to this technique.

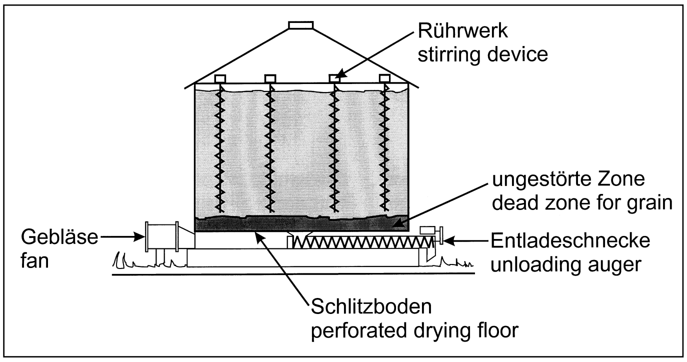


Fig. 3: Modern drying and storage of grain with stirring device