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# Methods and technologies in potato storage

*The choice of storage methods depends on the end-use and the associated requirements for keeping quality, tuber size and length of storage. Fundamentally, storage can be divided between bulk storage which may take place outdoors (potato pits) as well as indoors, and box storage. Pitting potatoes is simple but labour intensive and involves risks. Thus the system is only used nowadays for starch potatoes and now and again for short-term storage. Bulk storage indoors with air ventilation offers advantages of quality keeping. For amounts up to 500 t box storage is more cost-effective and can be combined with forced, space or wind ventilation.*

In Germany potatoes are only available direct from the field seasonally. To ensure supply over the rest of the year the tubers must be stored. The demands of storage differ according to the end-use and length of time and have led to several methodological-technical solutions for ventilation, loading into storage and removal from storage [1].

### Potato pits

The outdoor potato pit represents the oldest form of storage. Nowadays, however, this is mainly used for starch potatoes because of the increased weather dependence involved, the limited control of climate within the pit and the associated quality risks. Here, the tubers are mostly collected loose from the harvester and formed into long heaps on the field headland (*fig. 1*). It is important that the ground under the pit remains dry, even in wet weather conditions which can occur at storage. Covering with plastic sheeting stops the seepage of rain. Where frost is a danger a sufficiently thick covering of straw between potatoes and plastic sheet must be planned for [2]. Newer developments such as the use of non-woven fabric for covering the pit have helped to reduce the labour-economic input but can also not guarantee the exact temperature control possible with indoor storage [3].

### Bulk storage indoors

With bulk storage indoors the actual preparation and storage of the potatoes is no longer so dependent on weather influences. Additionally, the potatoes can be sufficiently dried and cooled-down after harvest through ventilation. Thus quality can be guaranteed, even over a longer storage period. Starting from an amount of between 400 and 500 t bulk storage is cheaper than big box storage and the former offers higher speeds for taking the potatoes into or out of storage. Thus this type of storage is used above all for potatoes for the further processing industry but also where larger amounts of eating potatoes are being handled.

Basic requirement for bulk storage is a building as watertight and insulated as possible. A ventilation system helps take heat and moisture out of the stored crop through using fans to draw colder air into the building and distribute it evenly through channels or tunnels under the potatoes [4]. From the aspect of labour economy, the underfloor channels have advantages because they avoid the setting-up of tunnels above floor level and their possible damage when the potatoes are taken out of storage. A difference should be made between the triangular wooden overfloor tunnels and the semicircular metal ones which are not so easy to repair. The exhaust air openings are positioned above the potatoes so that the air streams through the crop.

Through introduction of colder air, the potatoes are cooled-down and moisture transferred away from the tuber surfaces. This is important, especially at the commencement of storage, because it removed the conditions

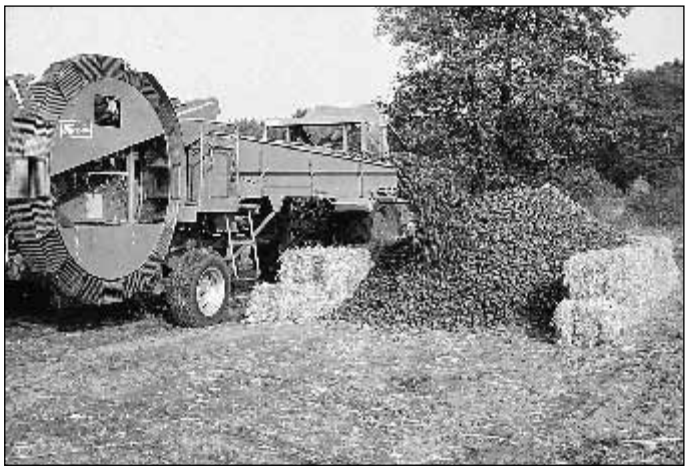

*Fig. 1: Harvester filling a clamp*

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*Fig. 2: Bulk store under roof with under floor ducts for ventilation*

in which diseases thrive. Through measuring the electrical resistance in the potato pile it is possible to record the otherwise hard to estimate progress of the drying and to use it as a control parameter [5]. A common problem in bulk storage is the appearance of storage pressure points. The causes to be considered in such cases are, alongside the height of the heap and the associated increasing pressure on the bottom layers, factors such as growth conditions, weight loss and the length of the ventilation period during storage as well as the variety of potato [6]. To avoid storage pressure points as far as possible, sometimes storage in big boxes is chosen.

#### Storage in big boxes

The possibility to store even small amounts separately is especially important with seed potatoes. Another positive aspect here is that the reduction of drops in the handling of the tubers, especially where the boxes are filled in the field, and this helps the retention of quality. On-farm, the boxes are transported by forklift and no additional transport technique is required. When emptying the store too, this system offers advantages in that the cold potatoes can be transported into a warm area without themselves being moved around. Tuber temperatures of 8 to 10 °C in preparation avoid the appearance of blackspot. The capacity of the boxes mostly used nowadays is sufficient for 0.8 to 1.5 t, in special cases up to 5 t. There is a wide range of possibilities for ventilation in box systems.

#### Forced ventilation

In this system the air, similar to bulk storage, is forced through the potatoes and is thus very effective in transporting warmth and moisture away from the tubers. The danger of rotting losses is thus reduced and also other diseases, e.g. silver scurf, can be better controlled. This is, however, associated with a somewhat higher cost in that a ventilation wall and special boxes with closed sides are required. Additionally, the boxes have to be stored quite closely to one another so that the palette floor forms a continuous air channel. Here, there are differences between the one-layer system, whereby the air from the palette flooring flows through only the boxes immediately above, and the two-layer system whereby the air has to flow through both layers. The one-layer system is technically more complicated in that only boxes with a double floor can be used. Their transport with a hand-jacked trailer is thus not possible.

#### Space ventilation

The advantage of space ventilation is its simplicity. Neither the complicated ventilation wall nor the precise stacking with every storage operation is necessary. Against this it has to be accepted that only one insufficient drying period in the storage phase can be achieved and there thus can be an increased risk of rotting. The ground principle of space ventilation lies in the precise fan-driven exchange of store air with outside air to cool the air between the boxes. An exchange of warmth and moisture out of the boxes occurs only through the natural air movement caused by the temperature difference between potatoes and store interior air. In store, no special conduction system is required. Instead, the inlet and exhaust openings, and the boxes, must be so positioned to give an as even as possible distribution of fresh air Minimum gap between boxes should be 10 cm to allow an unobstructed air exchange.

Regarding the positioning of the ventilation flaps, several systems are used in practice. In the so-called overthrow system the inlet and exhaust openings are on the same side of the building. The inlet air is first of all forced over the tops of the boxes at high velocity and then flows back through the stacks of boxes. In another variation the flaps for inlet air are in the gable walls and the exhaust flaps in the eaves sides. The inlet air is forced through a middle or side passage and from there flows through the boxes to the exit points.

*Fig. 3: A pallet box store with forced ventilation system*

#### Wind ventilation

The difference between space ventilation and wind ventilation is that fans for increased air exchange are not used for the latter. This means that energy costs and noise emissions are minimised. But the system's influence on storage temperature is severely limited because of the limited exchange of air. In order to use the wind movement for effective exchange of store air, the number and cross-sectional area of flaps is as large as possible. Compared with free convection ventilation where ventilation flaps are only situated in the upper parts of the building, here extra flaps sited lower down are aimed at creating a greater exiting effect for increased ventilation movement.

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