

Potato Storage – The Basics

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Options for Store Design

WHY STORE AT ALL?

A valid question to ask at this stage is why store. For many of us this question can be answered with "Because I have to!". Simply there is no market when the potatoes are harvested. However, many people do not store, many will sell the entirety of the crop off at harvest and shed the risk of keeping the crop. However the effect of every one attempting to sell their crop immediately would be to flood the market and a dramatic depression in prices. It is therefore essential that a large proportion of the crop is stored, to flatten out the supply curve in order to meet the demand curve. Those growing for the processing market have in the past been able to move the crop to the processor who would store it until ready to use it. There is a tendency for many processors now is to shed their own risks and to hand the storage back to the farmer. This may pose problems for some of us as it does require capital investment and yet another management task. However there can be significant benefits for those who can store, enabling you to control the stage at which you sell your crop onto the market and hence the possibility of higher prices at the latter end of the season as the non store potatoes start to run out. There are of course costs involved in such storage, which must be weighed against the benefits achieved from the higher prices. There is also the added excitement of speculating on the market in order to achieve the best prices and avoid the danger of the market collapsing beneath you.

An important part of planning for storage must therefore be a business plan to ensure that the added cost is more than met by the cost benefits of storage. We will look at the costs and benefits of storage later.

WHY STORE POTATOES?

NO MARKET AT HARVEST

REQUIRED BY CUSTOMERS

FLATTEN SUPPLY CURVE TO MEET DEMAND CURVE

IMPROVED VALUE LATER IN YEAR

TECHNICAL OPTIONS FOR STORAGE

So having decided that potato storage is a must, you need next to decide what form of storage is best suited. For that we need to know what options are available.

As would be expected the options are many and varied but initially can be split into two fundamental groups:

1. BULK
2. BOX

Each of these options can be split further, with any number of options being open to you as growers to choose from, however, for simplicity I have split the options as follows:

- Natural ventilation
- Forced ventilation, no temp control
- Forced ventilation temp control
- Refrigerated bulk storage
- Refrigerated/ambient, floor mounted coolers
- Refrigeration roof mounted coolers
- Wet air cooling
- Positive ventilation on box stores (pseudo letter box, "Super posi-vent")

Within each one of these there are further options which must be considered before the final option is selected for your farm. And that is an important point, there is no one blue print that is the best. The best system to use is the one that suits you and more importantly your market best. Increasingly the specification for storage systems are being based on the demands of the outlets, more especially the multiple retail outlets, and in order to supply to these markets these demands must be met.

I want to concentrate on the following variables that exist in the choice of the correct storage system:

1. Bulk or Box
2. Store layout/size
3. Insulation system
4. Storage regime required
5. Fridge or ambient cooling.

So lets look at some of these options in more detail and examine some of the pro's and cons that we need to consider in deciding on a storage system to suit us.

BULK vs BOX STORAGE

What are the pro's and cons of storing in bulk and box?

BOX STORAGE Pro's	Cons
Good quality control ability	Cost of boxes and maintenance

Good accessibility	Uneven air distribution (dead spots)
Multiple variety/grower in same zone	Cost of box filler
Able to deal with soil/damp potatoes	Wooden boxes acceptability??
Simple ventilation system	
Low damage	

BULK STORAGE Pro's	Cons
Good air/crop contact. = high rates of cooling	High damage risk (compression & handling)
Speed of loading/unloading	Problems with soil/wet
Lower cost grading handling equipment	Poor quality control
No box cost ie lower capital cost	Inaccessibility
Selective ventilation/gassing	Only one variety/grower per zone

STORAGE CAPITAL COSTS

1000 T ambient store

	BOX 8 high	BULK 12' deep
Item	Cost	Cost
TOTAL	120%	100%

The question must be raised then, why store in boxes at all?. This can be easily answered by realising that in many cases the benefits of box storage outweigh the cost savings of bulk storage, not least being that the market is demanding the quality control of box storage.

STORE LAYOUT

So assuming that the decision has been made to use box storage, the next question we might need to address is that of the layout and size of the store.

STORE LAYOUT/SIZE - FACTORS TO CONSIDER

- Box size/stacking height

- No. of varieties

- Need to get access

- Need for inspection

- Air distribution

- Speed of loading/unloading (harvesting rate & time elapse before curing/cooling)

- Ease of loading

- Storage regimes required

- Economics

INSULATION SYSTEM

All potato stores must have some form of insulation. This acts to prevent frosting and to conserve energy in the cooling process. Insulation can come in many forms and with varying degrees of insulation standard or 'U' value. So what system should you use? What standard of insulation do you need?

INSULATION SYSTEMS

- Straw Bales/Loose straw
- Quilts
- Glass fibre composite panels
- Spray polyurethane foam *
- Rigid 'styrofoam' boards *
- Composite panels

Of the systems identified, it is perhaps true to say that the use of straw, especially for new or refurbished installations, is not a recommended option. Whilst it operates very effectively in many stores around the county, the problems of vermin and moisture ingress make it less than acceptable for newer work. However, the use of straw for strawing down for condensation control still has a place even in some of the higher value stores.

Glass fibre composite panels are a possible option, but do offer a very good run for vermin and generally do not provide the 'U' value required for the low temperature storage of potatoes. Many of you considering the upgrade of an existing store may well have such a system in place already. This system will be adequate to provide frost protection only, and then only in a mild frost.

Environmental considerations must also be considered, as many insulation materials are traditionally blown using CFC's. Further consideration must be given to risk of fire and collapse, and many insurance companies will require you to check with them before using any insulation material.

ITEM	SPRAY FOAM	RIGID BOARD	COMPOSITE
Cost	100%	100 - 110%	150 - 200%
'U' Value	0.35 @ 80mm	0.35 @ 80mm	0.35 @ 80mm
Consistency of insulation	Depends on installation	Depends on installation	Good
Finish/look	Can be uneven	Good	Excellent
Washability	Poor	Reasonable	Excellent
Long term insulation	Acceptable	Good	Excellent
Suitability for retro-fit	Excellent	OK	Poor

A valid question to ask at this stage is "Just what standard of insulation do I need?". Basically, the requirements depend upon the type of store to be planned. There is an economic balance between the capital cost of insulation, the capital cost of cooling equipment and the annual running costs. For a refrigerated 1600T box store this can be summarised as follows:

'U' Value (thickness)	Installation cost	Fridge size	Fridge cost	Running cost
0.35 W/m ² °C (80mm)	£18,000	72 kW	£35,000	£6,032
0.50 W/m ² °C (56mm)	£15,000	82 kW	£38,000	£6,784
0.70 W/m ² °C (40mm)	£12,000	98 kW	£41,000	£7,904
1.00 W/m ² °C (28mm)	£10,500	116 kW	£45,000	£9,520
1.20 W/m ² °C (23mm)	£9,000	128 kW	£50,000	£10,608

It is clear from the figures spent on insulation is well spent and keeps the cost of refrigeration and running costs down, paying for itself in the first year. The costs shown do not illustrate the added benefit of improved quality through lower running times and hence less moisture removal.

The basic recommendations for insulation are 80mm for refrigeration and 50mm for frost protection only.

TEMPERATURE REGIMES

The design of a potato store must be made around the storage regime that is required by the market to which you are storing.

Broadly speaking, the higher temperature storage is required for those potatoes being stored for crisping and chipping, where the fry colour is essential, and skin finish less essential. Lower temperature storage is employed where the crop is aimed at the pre-pack market and the suppression of silver scurf, black spot and other disorders is required to produce the desired skin finish. Additionally the use of the lower temperatures can reduce the amount of sprout suppressant chemical required by reducing tuber growth.

In most potato stores however, the need for high humidity and low weight loss is essential. This is a subject that has caused much discussion over recent years and has been the subject of in depth research.

The ability to maintain high humidity in store requires careful engineering and good store management. The situation for fridge stores is very different to that for the ambient store, where the condition of the air is totally at the mercy of the elements. In all potato stores the use of a suitable humidity enhancer can be of benefit. I am currently engaged in the testing of such a device at a refrigerated store in S. Lincolnshire where the weight loss from two stores is being monitored, with the one store being equipped with a humidifier. The results from this trial will be of great interest to all growers.

It is true that all ambient stores will definitely benefit from improved humidity at times when the ambient humidity is low.

This discussion brings me on nicely to the final area that I wish to investigate in this session, that being the option of ambient or refrigerated temperature control.

AMBIENT OR REFRIGERATION

The answer to the question of ambient or refrigerated temperature control, or for that matter a combination of the two, as is the case at one of the stores at Chennells, must be based on three factors. Firstly, and most importantly, the temperature required in the store, secondly, the length of time that the crop is to be held and thirdly the capital cost of the installation. Broadly the application of ambient or refrigeration in relation to storage temperature must be based on whether the ambient conditions exist for the crop to cool successfully, and maintain temperature at the warmer end of the year. This judgement can be based on day degree data collected for the area, and can be summarised as follows:

Storage Temp	4°C	6°C	8°C	10°C
Month				
September	Fridge	Fridge	Fridge	Fridge
October	Fridge	Fridge	Fridge	Fridge
November	Fridge	Fridge	Fridge/ambient	Fridge/ambient
December	Fridge	Fridge/ambient	Fridge/ambient	Fridge/ambient
January	Fridge/ambient	Fridge/ambient	Fridge/ambient	Fridge/ambient
February	Fridge/ambient	Fridge/ambient	Fridge/ambient	Fridge/ambient
March	Fridge	Fridge/ambient	Fridge/ambient	Fridge/ambient
April	Fridge	Fridge	Fridge/ambient	Fridge/ambient
May	Fridge	Fridge	Fridge	Fridge
June	Fridge	Fridge	Fridge	Fridge
July	Fridge	Fridge	Fridge	Fridge
August	Fridge	Fridge	Fridge	Fridge

The table shows very clearly that the opportunities that exist for reliable storage with ambient air are limited to the higher temperature regimes with the shorter term storage. This emphasises the importance of a very good control system in the store, an example of which you will see this afternoon, and excellent management to make the most of the ambient conditions available.

The decision must be made as to the economic sense for the use of refrigeration as opposed to ambient storage. There are significant cost differences between the two systems, both in terms of capital and running costs.

TYPES OF FRIDGE SYSTEM

Fridge systems can be fitted to both bulk and box stores, the bulk store normally using a duct mounted evaporator, although ceiling mounted evaporators in conjunction with duct mounted recirculation fans have been used.

In box stores the refrigeration system can be either floor or roof mounted, generally working on the principle of cold air being blown over the top of the boxes and drawn back through the potatoes.

Generally the floor mounted system is most popular, as it offers the simplicity of installation, especially where the packaged unit is used. This is a system where the entire refrigeration plant is constructed in one unit at the factory and shipped wholesale to the farm and simply installed on the floor, connecting to air inlets in the wall. This system offers the opportunity of combining the ambient air with the refrigeration unit so that when the conditions outside are suitable, ambient air is used, otherwise the fridge is available.

The roof mounted system offers other benefits in the freeing of floor space. However, the system has to be installed as a split system, ie the evaporators, condensers and compressors are all separate, and hence the installation and maintenance costs are higher.

CONTROL OF HUMIDITY

We raised the question of humidity control earlier, how do the two options vary, and what can be done to improve the situation.

Firstly the refrigerated system does offer some degree of control over the humidity in the store, and with the right design of the evaporator coil, humidities in the high 90 - 95% range can be reliably achieved. Humidification enhancement systems have been used in some refrigerated stores but these can cause problems of icing on the evaporator coil, especially where the system introduces water droplets into the air. Other systems get over this problem by adding the water as a vapour, the Munters Humimax system being an example of this.

In the ambient system there is little or no control over the humidity in the store as the system is at the mercy of the weather. It is our feeling that many ambient stores would benefit from humidity enhancement.

A question I would ask you is **DO YOU KNOW WHAT THE WEIGHT LOSS FROM YOU STORE IS?**

TYPICAL WEIGHT LOSS

FRIDGE	AMBIENT
3 - 10%	5 - 15%

POTATO STORE

THE DECISION MAKING PROCESS – QUESTIONS TO ASK

- Do I need to store?
- Bulk or Box
- Capital available
- Storage regime in relation to intended market
- Store layout in relation to management of crop loading unloading and marketing
- Ventilation system in relation to cost benefits available, regime demands and storage period
- Type of system to install
- Correct store and system design and specification
- Competitive tendering
- Management of installation