Principles of Potato Storage
(Summary Sections)

by

R. H. Booth and R. L. Shaw
The Storage System

Storage moves potatoes through a period of time to make them readily available to consumers and to prevent wide fluctuations in supply.

Consumer requirements — which control this potato movement — include potatoes for human consumption, for seed, and for processing.

Storage, to a certain extent, replaces production on a continuous basis. By prolonging production periods storage requirements are reduced.

Storage facilities add to the cost of producing potatoes. Potatoes from storage always cost more than freshly harvested potatoes.

The potato storage reservoir absorbs the surplus flow of potatoes during the new harvest for consumer use later. Potatoes are then released from the storage reservoir to supply future demand.

Only place the amount of potatoes required to satisfy future consumer demands in the storage reservoir. Over-storage will result in over-supply, low prices and financial loss.

To manage the flow of potatoes to and from the storage reservoir, information on the influence of over-supply or under-supply on prices and demand is of utmost importance.

Detailed information on production patterns, marketing systems, and total and varying demand is necessary to determine overall storage patterns and requirements.

Potato storage must be an integrated part of the total potato production process.

The triad of production-storage-demand is a multiple approach based on the consideration that potato production should be in terms of quantities of tubers made available to consumers.

The selected storage system must form part of and be acceptable to both production and demand patterns or it will not be utilized effectively.

Particular storage needs are to a large extent determined by total and specific consumer requirements and the magnitude, duration and frequency of harvests.

The above factors together with variable storage costs and social conditions make storage needs very location specific.
There is no "best" storage system. Different systems will be more or less appropriate under different technical, economic and social conditions.

The Storage Complex

Many factors interact to determine the success or failure of a storage activity. Some factors, listed below, are discussed in following summary sections.

Socio-economic factors. We must know why we want to store potatoes, how many we want to store, and for how long we need to store them. We must, therefore, know present production and demand patterns and judge how storage will fit in and change the existing system.

Biological factors. Potato tubers are living plant tissue and as such they consume oxygen and give off carbon dioxide and heat during respiration. This living tissue is influenced by many pre- and post-harvest factors. A thorough understanding of these factors is necessary for successful storage.

Engineering factors. We must construct (or modify) a building to contain and store the potatoes. We must know the size of the enclosure required and it must be designed for easy loading and unloading. This requires a knowledge of materials of construction. We must plan and design for the correct internal climate to conserve the potatoes. This is accomplished by a knowledge of the external climate and psychrometrics, the thermodynamic properties of air. This helps us decide on possible alternatives of natural ventilation, forced draft ventilation, refrigerated circulation. We need also to understand the insulating properties of building materials.

Managerial factors. Storage management is as critical to the total system as are production management and marketing. It requires a knowledge and understanding of the total production-storage-demand system in addition to detailed knowledge of potato storage technology. Proper management is essential and helps make the total system more efficient and less costly.

1. Respiration

During tuber respiration atmospheric oxygen and tuber dry matter are consumed and carbon dioxide and heat are produced. Thus potato stores must provide an adequate supply of oxygen and permit removal of excess carbon dioxide and heat.

Tuber weight loss from respiration is small. It amounts to about 1 percent to 2 percent of fresh weight during the first month, about 0.8 percent per month thereafter and rises to about 1.5 percent per month when sprouting is well advanced.

The most important effect of tuber respiration is the production of heat. Heat production depends on rate of respiration, which increases about twofold for every 10°C rise in temperature in the range 5° to 25°C. Below 5°C the rate of tuber respiration also increases.

Respiration rate is higher in immature and uncured tubers. Heat output of potatoes during storage is approximately:

<table>
<thead>
<tr>
<th>Tuber Type</th>
<th>kW/hr x TM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Immature potatoes</td>
<td>259</td>
</tr>
<tr>
<td>Mature potatoes during store loading</td>
<td>300</td>
</tr>
<tr>
<td>Mature potatoes during curing</td>
<td>200</td>
</tr>
</tbody>
</table>

If this heat is not removed, potato temperatures rise by at least 0.25°C per 24 hours.

Ventilation of the store is required to remove this heat and control the store environment.

2. Water Loss

All water lost before tubers are sold means a loss of sales income because tubers are sold by weight.

Depending on the demand, a water loss in excess of 10 percent may affect tuber marketability because of their unattractive and poor shriveled appearance and because of greater peeling problems and losses.

Water is lost from tubers by evaporation.

The rate of water loss from any particular sample of potatoes is proportional to the water vapor pressure deficit (VPD) or drying power of the surrounding air.
Varieties differ greatly in length of dormant period.

Immature tubers have longer post-harvest dormant period.

Damaged and diseased tubers sprout sooner than sound tubers.

Ordinarily the higher the storage temperature over a range of about 4°C to 21°C the shorter the residual dormant period.

Fluctuating storage temperatures generally reduce the residual dormant period, but varieties respond differently to such conditions.

The continuation of dormancy break is sprout growth.

There is no correlation between length of the dormant period and the subsequent rate of sprout growth.

The main factors influencing rate of sprout growth are: variety, temperature, humidity, composition of the atmosphere, and degree of exposure to light.

Sprout growth is slow at a temperature of 5°C and below. Above 5°C growth rate increases to a maximum at about 20°C above which growth rate declines.

Humidity affects the form of sprout growth more than the rate: the degree of sprout branching is greater under dry conditions and the production of adventitious roots is greater under humid conditions.

Sprout growth is stimulated by an increase in CO₂.

Potato sprouts grown in the light develop chlorophyll and are shorter and sturdier than those grown in the dark.

In addition to the use of low temperature storage and exposure to diffused light, sprout growth may be controlled by a number of commercially available chemical sprout inhibitors.

Chemical sprout inhibitors include:

- Propham or IPPC (isopropylphenyl carbamate),
- Chlorpropham or CIPC (isopropyl chlorophenyl carbamate),
- Tecnazene, Fusarex or TCNB (tetrachloronitrobenzene),
- MH (maleic hydrizide).

These chemicals can only be applied to consumer potatoes. They must not be applied to seed tubers.

Prior to application to food products (consumer potatoes), all chemicals should be rigorously screened and then used only in strict accordance with the manufacturers recommendations and food additive regulations of the country concerned.

With the exception of MH, which is a pre-harvest foliar spray, all the above chemicals are used on tubers after harvest. All these post-harvest chemicals are active in the vapor phase. They can be dusted on the tubers with an inert filler or the active chemical may be vaporized and blown in the ventilating system through the stored tubers.

All the above chemicals except TCNB also inhibit the wound healing or curing process.

Application, therefore, best delayed until the curing process is complete.

Use of chemical sprout inhibitors requires considerable management skill and experience.

4. Quality Changes

Changes in tuber sugar levels considerably influence culinary and particularly processing quality of tubers.

Storage temperature influences sugar content.

A decrease in storage temperature, particularly below 10°C, causes an increase in sugar content.

Both sucrose and reducing sugars accumulate during low temperature sweetening.

The color of fried processed products is mainly the result of reactions between amino acids and reducing sugars. Of these the content of glucose is most closely correlated with browning.

Low-temperature sweetened tubers may be desweetened by reconditioning for about 2 to 3 weeks at 15°C to 20°C.

The concentration of sugars also exhibit an upward trend after prolonged storage: senescent sweetening.

Senescent sweetening, which is most pronounced following storage at high temperatures, is not reversible.
Losses

Post-harvest losses reduce either quantity or quality or both.

Quantitative losses of potatoes are readily apparent.

Qualitative losses are frequently overlooked or underestimated and are of importance because they can considerably reduce a crop's value.

Losses should always be defined within the local environment because what may be considered a loss under one situation may be acceptable under another situation.

Losses result from physical physiological or pathological causes or combinations of all these.

A. Physical Factors

Losses caused by mechanical injury are frequently overlooked. Enhanced physiological and pathological losses makes these difficult to estimate.

Mechanical injury occurs in many forms and arises at all stages from pre-harvest, through harvesting and all handling operations to exposure in the market and finally in the home.

Up to three-fourths of total tuber damage happens at harvest. Damaged tubers should not be stored.

Mechanical injury may broadly be divided into two categories: shatter, when the outside skin is broken, and internal bruising sometimes called blackspot when the tuber flesh becomes dark and discolored and not necessarily associated with a break in the skin.

Shatter is further subdivided into surface scuffing and deeper flesh injury.

All types of damage may be caused by the same impact.

Tuber condition frequently determines which type of damage is sustained:

- dehydrated or flaccid tubers are more susceptible to internal bruising;
- hydrated or turgid tubers are more susceptible to shatter damage.

Degree of damage is also greatly influenced by soil condition and harvesting care.

Tubers are more susceptible to mechanical injury at low temperatures.

Very minor skin injury will result in increased physiological and pathological losses.

B. Physiological Factors

Factors affecting physiological losses due to respiration, water loss, dormancy and sprouting and quality changes are summarized in Summary Section 1.

Additional physiological injury may result from exposure of tubers to both high and low extremes of temperature.

Exposure to direct sunlight or storage at very high temperatures may result in cell death from asphyxiation resulting in black heart and similar symptoms.

Tubers exposed to freezing temperatures below about -2°C are injured because of internal ice formation.

Further storage and market losses may result from various physiological disorders. These frequently result from abnormal pre-harvest growing conditions.

Degree of damage is also greatly influenced by soil condition and harvesting care.

C. Pathogenic Losses

Attack by microorganisms probably cause the most serious gross post-harvest losses.

Such losses may be quantitative through rotted of sound tissue or qualitative as the result of surface or blemish diseases. A further group of diseases also affects the eyes and are important in seed tubers.

Post-harvest diseases are divided further into those in which infection becomes established in the field prior to harvesting and those where infection occurs at or following harvesting through wounds.

Few pathogens are capable of spreading and causing disease spreading during storage. Where spread of disease does occur in storage it is usually the result of soft rotting bacteria.

Some important tuber diseases and their mode of infection are listed below:

<table>
<thead>
<tr>
<th>Disease</th>
<th>Mode of infection</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A. Rots</strong></td>
<td></td>
</tr>
<tr>
<td>Late blight (Phytophthora infestans)</td>
<td>Field, spore contact</td>
</tr>
<tr>
<td>Pink rot (Phytophthora erythroseptica)</td>
<td>Field via stolon</td>
</tr>
<tr>
<td>Brown rot (Pseudomonas solanacearum)</td>
<td>Field via injured roots</td>
</tr>
<tr>
<td>Black leg/Soft rot (Erwinia spp.)</td>
<td>Field via stolon and post-harvest via lenticels and wounds</td>
</tr>
<tr>
<td>Dry rot (Fusarium spp.)</td>
<td>Post-harvest via wounds</td>
</tr>
<tr>
<td><strong>B. Blemish diseases</strong></td>
<td></td>
</tr>
<tr>
<td>Common scab (Streptomyces scabies)</td>
<td>Field via lenticels</td>
</tr>
<tr>
<td>Powdery scab (Spongospora subterranea)</td>
<td>Field via lenticels</td>
</tr>
<tr>
<td>Black scurf (Rhizoctonia solani)</td>
<td>Surface sclerotia</td>
</tr>
<tr>
<td>Silver scurf (Helminthosporium solani)</td>
<td>Field</td>
</tr>
<tr>
<td>Skin spot (Oospora pustulans)</td>
<td>Field</td>
</tr>
<tr>
<td>Wart (Synchytrium endobioticum)</td>
<td>Field</td>
</tr>
</tbody>
</table>
Additional pathogenic losses may be caused by insect, nematode, and other animal pests such as birds and rodents. The most damaging post-harvest pest is the potato tuber moth, *Phthorimaea operculella*, and associated species.

In stored seed tubers, aphid infestation of young sprouts may disseminate certain important virus diseases.

**Loss control**

**Pre-harvest measures:**
- Varietal selection,
- Site selection,
- Site preparation,
- Cultural practices.

**Post-harvest measures:**
- Physical care, harvesting and handling; time of harvesting (soil conditions, tuber maturity);
- Chemical good sanitation and disinfection of stores and implements; chemical control of pests and diseases either in the field or post-harvest, as appropriate.

(Curing is a wound healing process during which general skin strengthening also occurs. It first involves suberization of cells adjacent to wounds followed by the formation of a wound periderm or cork layer that effectively retards water loss and acts as a barrier against infection. This process occurs at temperatures of 12°C to 18°C when the relative humidity is 85 percent or above in the presence of O2, reduced or low temperature storage.

Choice of Storage Method

Before the selection and design of a store we must have certain information for example:

(i) How many potatoes will be stored and for how long? This determines total size of facilities and influences type of ventilation requirements.

(ii) How many varieties and qualities will be stored? As only one variety and one quality should be stored together, this will influence store type (bulk or container) and size of individual units.

(iii) How many potatoes will be harvested and handled per week? Practical experience has shown that individual storage rooms should have the capacity for one week's harvest.

(iv) What are the characteristics of the variety and condition of the tubers? This will influence degree of control needed over the storage environment.

(v) What is the climate during the storage period? This will influence store and ventilation system choice and design and the selection of building materials.

The most efficient method of storing potatoes is not absolute. Select methods in terms of acceptability to the total production-storage-demand system to yield maximum returns on the investment available while keeping losses as low as possible.

Different systems will, thus, be more or less appropriate in different areas, seasons, and even at different times within the same long storage season.

Alternative Storage Methods

Delayed harvest or in-ground storage is simple and may be used for up to 3 months under certain conditions. It is low in cost. Problems arise from sprouting, disease losses particularly in wet heavy poorly drained soils, increased exposure to pest attack and tuber greening.

Clamps and pits are simple temporary structures that can be used in the field or near the house. Useful where large capital expenditures are not desired or available. Essentially the system involves piling the harvested tubers in heaps and covering them with straw and possibly soil. Exact clamp design must

Summary Section 4.

Storage Methods
be determined to suit local prevailing conditions.

Multipurpose and adapted buildings are common structures for storing potatoes particularly in many developing countries. As a multipurpose building must accommodate other uses its effectiveness for potato storage is often reduced. Multipurpose buildings range from the use of upper and lower floors of country dwelling houses through general warehouses, to multipurpose cold stores. In adapting buildings for potato storage particular attention should be paid to insulation and ventilation.

Purposely constructed potato stores. Size is one of the first considerations in constructing a special store. This is determined by total and weekly harvests. Each 1 TM of tubers stored in bulk occupy 1.5 to 1.6 cubic meters. The height to which tubers can be stored in bulk depends on storage environment and type of ventilating system. In stores relying on natural convective ventilation, potatoes can be piled to 2.0 m high in cool areas and 1.3 m high in warmer areas. Where forced draft ventilation is used they can be piled to 3.5 to 4.0 m. The walls of the store should extend 1.0 m above the stored crop. The most useful potato storage containers are 0.5 or 1.0 TM boxes for consumer potatoes and shallow seed trays for seed tubers. Jute sacks offer little advantages over bulk or box storage.

Once the size of a store has been determined, specific design will depend upon local experience and availability and costs of materials. Access to both the store site and into the building itself must be considered. The principle of “first in — first out” should always apply.

Purposely constructed stores range from low-cost rustic structures through intermediate types with natural or forced draft ventilation (above ground or, where appropriate, semi-subterranean) and finally to large scale sophisticated refrigerated stores.

Special Considerations

In some respects storage requirements of all potato tubers are the same: two examples being avoidance of diseases and excessive shrinkage.

Special considerations for seed storage are those which influence and which are often characteristic of a particular variety.

Seed storage methods and management should provide the desired development of sprouts prior to planting in terms of both number and size. The optimal number of sprouts per tuber, which determines the number of main stems per tuber, is influenced by seed size, planting density and growing conditions. The actual number of sprouts produced per tuber is influenced by variety, tuber size, and degree of apical dominance. The degree of apical dominance in a given variety is largely influenced by storage conditions, especially by temperature.

If a potato tuber is stored at a temperature that promotes a short dormant period, the young buds at the apical end start growing and growth of the older buds on the tuber is suppressed. This is known as apical dominance. On the other hand, if a tuber is stored at a temperature that prolongs the dormant period, growth, when it does begin, tends to occur in all buds on the tuber at the same time. Thus, generally, if a variety normally tends to produce too many tubers for a sufficiently high proportion of them to grow to a required size, one aim of seed storage is to reduce number of stems and thus reduce the number of tubers produced. This is done by encouraging apical dominance through storage at about 15°C until apical sprouts are 1 to 2 cm long. The sprouted tuber is then held at about 4°C to prevent too great development of sprouts prior to planting. If a variety tends to produce few stems and few tubers which become too large, the seed storage aim is to increase number of stems and, thus, tubers. This is accomplished by holding back the seed at about 4°C until a few weeks before planting and then storing in light (natural or artificial) at about 15°C to provide multiple sprouting.

Where manipulation of storage temperature is not possible,
control of apical dominance may be manually controlled. After storage at uncontrolled, fairly high temperatures, sprouts begin to grow following the end of the variety's natural dormancy period. The degree of apical dominance/number of sprouts produced will also largely depend on the variety. In varieties which show strong apical dominance this may either be maintained by leaving the tubers undisturbed or be destroyed by removing the apical sprouts by hand. This promotes many other eyes to sprout.

To produce short sturdy sprouts for minimal loss and damage and maximum vigor, sprouting should occur in either artificial or natural light. Sprouts produced in the dark show excessive growth, are weak and etiolated, prone to damage and also have much higher levels of moisture loss. Recent suggestions are that in many varieties apical dominance is less pronounced in tubers stored in the dark than in those stored in the light. Artificial light is commonly applied by vertically suspending fluorescent light tubes between stacks of seed trays in which the tubers are stored only 1 or 2 layers deep. This provides sufficient illumination over the whole stack and use of fluorescent lights avoid excessive heat gains.

Where artificial lighting is unavailable following their removal from controlled temperature stores, stack tubers in seed trays in glass houses or in any open structure that permits good light distribution.

Where neither controlled temperature storage nor artificial lighting facilities are available, seed tubers may be advantageously stored continuously exposed to natural diffused light. However, they must be protected from prolonged exposure to direct sunlight. Greening of tubers which occurs on exposure to light is not detrimental to seed tubers. In fact, greening is reported to increase tuber resistance to certain pests and diseases. Simple structures that permit light penetration and which also provide good ventilation are easily designed.

In addition to sprouting, other physiologically aging processes occur during tuber storage. These processes are influenced by storage conditions, mainly temperature. Generally, seed becomes physiologically older with increasing day degrees. Physiological age of seed at planting time affects the subsequent performance in terms of earliness and yielding potential. When an early crop is the major requirement, then physiologically old seed with well developed sprouts should be used. When a longer growing period is available and from which maximum yields are desired, then physiologically young seed should be used.

The storage structure has three major functions: retention of tubers, weather protection, and environment control.

(i) Retention of tubers. The floor and walls must support the tubers which should be considered as having a mass of 641 kg/m² per meter of depth.

- with potatoes stored in containers the total pressure is on the floor;
- when potatoes are stored in bulk a considerable portion of the weight is against the walls. We must know how to calculate this force and the walls must be constructed strong enough to retain this pressure thrust.

(ii) Weather protection requires exterior surfaces of roof and walls to be weather proof against wind, rain, and, in the case of consumer tubers, against light.

- in areas of high solar radiation a light colored building will help reflect this solar energy,
- commonly used weather protection materials — sheet metal and corrugated asbestos — have poor insulation values and additional insulation is necessary.

(iii) Environmental control. Good insulation is a requirement for all potato stores to make environmental control possible.

- Based on an ideal inside temperature of 5°C, potato stores should be insulated to a (U) value of

\[
\text{Insulation Terms and Symbols}
\]

Thermal conductivity \((k)\) is the quantity of heat flowing through 1 square meter of the material, 1 meter thick in 1 second when there is a 1°C temperature difference between the faces. The units of \((k)\) are expressed in watts/m°C or joules/second/m°C or kilojoules/hour/m°C. Thus, the lower the \((k)\) value of a material the better its insulating efficiency. The \((k)\) value increases if the material becomes wet as water is a good conductor of heat.

Thermal resistance \((R)\) is the measure of resistance to heat.
flow. If the thickness of a material is increased there is a corresponding increase in \((R)\) value. 

\[
(R) = \frac{m^2 \times ^\circ C \times \text{sec}}{\text{ joule}} \quad \text{or} \quad \frac{m^2 \times ^\circ C}{\text{ watts}}
\]

Thermal transmittance \((U)\) is defined as the quantity of heat in joules which will flow through 1 square meter of structure in one second when there is a 1°C temperature difference between the air on each side. The \((U)\) value determines the amount of heating or cooling needed to maintain the desired storage temperature. The units of \((U)\) are

\[
\frac{\text{watts}}{m^2 \times ^\circ C} \quad \text{or} \quad \frac{\text{joules}}{m^2 \times ^\circ C \times \text{sec}}
\]

\[
(U) = \frac{1}{(R)} , \quad (R) = \frac{\text{thickness}}{(k)}
\]

Thus, if a store wall has a \((U)\) value of

\[
\frac{4.0 \text{ kJ}}{\text{hr} \times m^2 \times ^\circ C}
\]

and the exterior temperature is 25°C and the interior temperature is 8°C, 68 kJ will pass through each square meter every hour.

To maintain insulating materials dry, vapor barriers are sometimes required.

Psychrometrics for potato storage. Ambient air is a mixture of dry air and water vapor.

As air passes through the stored potatoes enthalphy increases by the number of joules picked up from the potatoes.

The amount of air with its increase in enthalphy must equal or exceed the amount of heat determined by total cooling requirements if the desired store temperature is to be maintained.

When any two air properties are known the others may be read from psychrometric charts.

The two easiest properties to measure are dry and wet bulb temperatures.

Psychrometric properties of importance in potato storage:

- **Dry bulb temperature** .... °C
- **Wet bulb temperature** .... °C
- **Dew point** .... °C
- **Specific volume** .... m³
- **Volume** .... kg dry air
- **Relative humidity** .... % RH
- **Vapor pressure** .... millibars
- **Enthalphy (heat content)** .... kg dry air

Cooling Requirements

The maximum cooling load is made up of the following components:

(i) cooling load from field heat to storage temperature including high initial respiration,
(ii) heat produced by respiration during storage,
(iii) heat gain through structure,
(iv) heat gain by air leakage,
(v) heat from fans and other equipment.

Specific heat of potatoes is

\[
\frac{3430 \text{ kJ}}{\text{TM} \times ^\circ C}
\]

Once the maximum cooling load is determined the means of supplying this can be determined.

From the characteristics of the cooling air available, the volume of air needed can be calculated which determines the ventilation requirements.

Ventilation Systems

Ambient Air Ventilation may be either Natural Convective Ventilation (NCV) or Forced Draft Ventilation (FDV).

Ventilation with artificially cooled air, supplied either by evaporative cooling or refrigeration.

In areas of very low relative humidity the VPD of the ventilating air must be reduced by artificially humidifying the air.

Air Distribution

Complete false floors (small NCV stores).

System of ducts (FDV stores).

Ductsystem usually consists of one main duct and several lateral ducts.

Duct size is calculated from the volume of air required using the velocity method in which air velocity is reduced progressively through the system: main duct air velocities should be 10-13 m/see, below 10 m/see in lateral ducts and no more than 4 m/sec in exhaust openings. A minimal cross sectional area of

\[
1300 \text{ mm}^2
\]

of potatoes ventilated is usually recommended.

Lateral ducts may be above or below ground level. Lateral ducts should be evenly distributed no more than 2.0 m apart and usually no longer than 12 to 14 m.

To assist in even distribution of ventilating air the crops must be level filled in the store and the inlet and exhaust openings well placed.

Remember that ventilating air will always take the path of least resistance.

Where artificially cooled ventilating air is used a system of air recirculation will be necessary.

Fans must be selected to deliver the necessary volume of ventilating air and to be able to work against the resistance to the airflow provided by the ducts and the potatoes.

Two types of fans commonly used in FDV potato stores are centrifugal fans and axial flow fans.
Store management is as critical to the system as are production, management and marketing.

Pre-storage phase
Even the best facilities require that only good quality tubers be stored.

History of crop and characteristics of variety must be known.

Knowledge of total production-storage-demand system.

Storage phase
Selection of internal climate is a compromise among many factors which must be fully understood.

Drying.
Curing. 15°C and 85 percent RH.

Holding.
8-10°C consumer tubers 3 months,
4-7°C consumer tubers longer term,
10°C processing tubers 3 months,
7-8°C processing tubers longer term,
5-12°C seed potatoes 3 months,
2-4°C seed potatoes longer term.

Ventilation management.
Use of sprout inhibitors.
Possible use of light in seed stores.

Raise and control temperature before unloading.

Handle tubers gently.

Change tuber temperature slowly.

Conditioning of processing potatoes.

Chitting and pre-sprouting of seed.

Post-storage phase

Access to market information.

Ability to respond to market information.

Stores must have good access.

First in — first out.

Information on influence of over- and under-supply on market prices and demand.

Management Practices During Storage

Temperature monitoring — store and ambient.

Ambient - glass maximum-minimum thermometer.

Store/potatoes.

glass thermometer in tube, remote station thermisters or thermocouples.

large proportion of ventilating done at night, automation is based on a differential thermostat, must always inspect crop visually.

Humidity control.

automatic, excess moisture leads to rotting, usually temperature control is considered the dominant management factor.
Any storage system costs money and even if not used it adds to the cost of production. More complex stores are usually more costly. Seek the most cost-effective storage system.

In a seasonal production system with no storage system, prices of potatoes may fall below production costs at harvest time, but rise very much higher later. With storage the price at harvest time need not fall below production costs but later in the year it will not rise as high as when storage was not practiced.

Storage does not guarantee a profit but it may reduce risk of heavy loss and does provide an alternative.

The expected profit from storage may be calculated by subtracting from the expected increase in returns the costs of the structure, store management, handling and interest.

The change in return is the expected difference in value of the produce at the beginning and end of the storage period. The three major factors that influence returns are changes in prices and storage qualitative and quantitative losses.

Structure costs can be subdivided into capital investment and annual maintenance costs. Some simple stores have low fixed capital investment and high annual costs while more complex purpose-built stores have high fixed investments.

Stores involving substantial fixed investment require a confident view of the long-term profitability of growing and storing potatoes.

Stores with short-term investments allow greater flexibility in the decision to store or not to store depending on production and marketing conditions.

Management costs tend to increase with the degree of sophistication of the store and installed ventilating system.

Availability and costs of management skills are an important storage consideration.

Loading and unloading costs include the costs of labor and the cost of any equipment used.

Interest charges on all capital employed in the storage system must be considered. From this point of view the value of the crop stored is usually by far the most significant item.

With small producers cash flow and cash availability are frequently overriding considerations.

In the present world situation inflation will also, in many situations, be a major consideration.