



Future Growers

Module 9: Handling and storage

Briefing paper

OVERVIEW

1. Introduction

2. Harvesting and post harvest handling

- Picking and digging
- Mechanical harvesting
- Harvesting
- Handling and sanitation
- Washing and grading
- Transport and packing

3. Storage

- Reasons for storing crops
- Reasons why storage of crops is not always viable
- Storage methods
- Avoiding storage problems
- Examples of individual crop requirements

4. Examples of individual crop requirements

Much of the information for this module comes from the HDRA book Organic Vegetable Production by Gareth Davies and Margi Lennartsson.

Introduction

Harvest, transport and storage of vegetable crops can have a huge impact on the quality of the produce, affecting the proportion of the crop that can be marketed and the price it will attain.

All growers will need to harvest, handle and transport their vegetables even if it's only from the field to the pack house. In some cases they will be transported over long distances to wholesalers, packers or consumers. During this process, produce should be handled as little as possible in order to minimise deterioration and risk of damage.

In general, organic crops can be stored using the same methods as conventional crops and there is no evidence to suggest that organic crops store less well than conventional crops under the same conditions.

1. Harvesting and post harvest handling

Picking, digging and lifting

Most crops on small to medium operations will need to be harvested by hand. Some crops are very labour intensive to pick – for example soft fruit, beans and tomatoes. Costing additional labour for harvesting is crucial to ensure these crops are profitable.

Mechanised Harvesting

There are mechanical harvesters for potatoes and other root crops that can be bought fairly cheaply second hand. Mechanised harvesting is most suited to larger scale production where you are harvesting all your crops in one go, however some machines can be useful even on a smallish scale. Root crops are the most suited to mechanical lifting and hand digging them is time consuming and bad for the back. Small machines can be bought which will lift one or two rows at a time.

Careful planning of transport at harvest time can also save valuable time and effort. A small trailer that can follow you down a row can avoid endless handling to the side of the field.

The decision on whether to invest capital in machinery or spend money on labour during the year could be affected by the following factors

- Access to funds – cash flow
- Ethical considerations – desire to reduce fuel use, or involve community in work
- Availability of good labour – especially at peak times. This can be the case even if you want to get machinery. For instance there is no point spending

money on a large potato harvester that needs 5 people to operate it if you can only ever get 3 people on site at any one time

- Size of tractor - or horse

Harvesting

It is vital to harvest produce at the correct time and under the appropriate (cool and dry) weather conditions. It is unadvisable to harvest in the rain though this of course sometimes unavoidable. Conversely in sunny conditions make sure produce is rapidly transferred to cool or shady locations.

At harvest take care to handle and grade produce to avoid damage. This includes trying to minimise handling for instance by harvest, grading and packing in the field or on mobile rigs designed for the purpose. Hand graded produce (though more time consuming) is generally less damaging.

Be aware of the H&S regulations – for instance regarding required period between applications of manure and harvesting, also make sure harvesting equipment is kept clean

Handling and sanitation

Washing can reduce incident of post-harvest diseases (and thus maintain appearance and storage life) of fresh produce. If washing vegetables only water (liquid, steam or high pressure) can be used, or organically approved cleaning agents, in which case produce should be rinsed afterwards.

When sorting fresh produce in enclosed spaces the two most important factors are temperature and humidity. Basically the cooler the temperature (up to a point) the longer the produce will keep, as respiration, aging, moisture loss, spoilage due to micro organisms and growth are all slowed at lower temps. Freezing however is not normally suitable so limit temperature to 1-2°C or above, a constant temperature is also preferable, and try to prevent condensation which can lead to rotting and deterioration of produce.

Keeping relative humidity above 85% helps reduce moisture loss. However this is often difficult at low temperatures as refrigeration removes moisture.

Traditionally organically grown root vegetables are marketed unwashed which improves their keeping quality and is in line with a reduced emphasis on cosmetic attributes. Whether to wash or not however will depend on soil type and weather conditions at harvest. Customer perception is also important, some associate dirty carrots with healthiness others might prefer to have them washed. Usually washed produce sells quicker in a shop or market situation.

If you are considering bagging salad you will almost certainly need some form of washing facility, though this could be as simple as an old bath. Most other produce can be sold unwashed.

Growing for the wholesale market does impose some discipline on grading, and there are official grading standards, which can be used as a sanction against poor quality produce. Quality is a more subjective matter when marketing through boxes, with uniformity and minor skin blemishes becoming less important.

Equipment you might need includes; a grading line, tipper for bulk bins, tub for washing veg in, chopping area for cutting and trimming etc. weighing scales, bags for potatoes carrots etc, pallets, cling wrap, pallet truck. Put some thought into how the grading and washing line will operate and set it up for maximum efficiency – for instance have the end of the line near the door so you can load boxes straight into the van.

Transport and packing

- A dedicated packing area is essential. It should be light and airy and easy to clean.
- Running potable water is essential for washing and some means of trapping silt from the washings will prevent blockage of drains as well as saving soil.
- Boxes are most easily packed if they can all be laid out together. This could be on single, double or triple shelving with storage for empties beneath. Counter space for weighing and bagging should also be close at hand.
- Finances may govern choice of box. Plastic boxes can last several seasons, will not be affected by containing wet produce, and will remain robust for handling and stacking. Their purchase price is around three times that of cardboard boxes but this initial cost can be passed on to the customer in the form of a deposit. Waxed printed boxes are available from Soils Association Sales and Services. Alternatively simple cardboard boxes are cheaper and can be printed with a logo, but they will not last as long. At the very early stages when numbers are small and finances tight you may be able to get free second hand boxes from a local vegetable wholesaler or grocer though these will need to be lined to avoid possible contamination from residues on the boxes.
- If possible transport produce in sealed containers or packaging that prevents contamination and drying out. Packaging should be food grade and free from residues. You can re-use packaging but if it has previously been used for non certified produce you will need to line it first.
- If funds permit a refrigerated van in summer is very helpful, however ensure transport is regularly cleaned.
- Excess packaging should be avoided and ecologically sound materials should be used
- Vegetable boxes should be packed with the heavy items at the bottom and more delicate ones at the top. They should not be left standing for long periods in hot vehicles (especially in the summer.)

2. Storage

Reasons for storing crops

- Providing regular income and avoiding cash-flow problems
- Spreading workload throughout the year (to maintain staff)
- Achieving continuity of supply to customers, especially where direct marketing is used
- Increasing quality of the produce over a longer period
- Increasing consumer confidence by ensuring that they are receiving local produce over a longer period (as opposed to bought in top-ups)
- Avoiding oversupply and market saturation at peak harvest time
- Accumulating produce for peak periods of demand e.g. short term cold storage of perishable crops can enable more efficient use of labour, as several days' supply can be harvested at the same time)

Reasons why storage of crops is not always viable

- Lack of incentive – many growers are able to plan for and market their produce as it is harvested
- Economies of scale – small businesses are unable to generate the funds necessary for capital investment in sophisticated harvest rigs or storage facilities
- A wide range of crops are grown – the variety of crops on a holding and the different market outlets characteristic of many organic farms complicates the provision of adequate storage facilities that satisfy needs
- Lack of technical and financial information – there is little information on the fluctuation of wholesale market prices during the year and this makes it hard for growers to decide whether it will be worth storing produce or not.

Storage methods

- Can vary depending on several factors:
 - produce to be stored
 - intended market outlet
 - length of time of storage
 - farm facilities
 - quantity and value of crop
- Growers should assess their individual storage needs

Field Storage

- Storage of vegetables *in situ* in the field, generally over the winter
- Suitable for crops such as Parsnips, Carrots, Swedes and Savoy cabbage

- For parsnips and carrots this provides the best storage method to preserve skin finish for the supermarket trade
- Carrots usually need insulating with straw to protect against frost, however on a field scale this will be costly and the straw will be difficult to dispose of
- In general, field storage is low cost and simple to implement
- On heavy land it may not be appropriate as rotting may be a problem
- Bad weather in winter can make lifting a problem

Clamps

- Indoor and outdoor clamps are suitable for bulk storage of vegetable crops and are often used for root vegetables
- They use ambient temperatures and ventilation and can be placed in adapted buildings e.g. barns
- They are usually above ground and can be walled-in using hay bales
- Clamps are often covered with straw to protect produce, dampen down temperature fluctuations and keep produce in low light
- Produce can be placed on pallets to help ventilation
- Suitable for short (until December) to medium (until March) term over winter storage
- Rodent damage can be a problem
- Frost damage can be a problem if they are outside
- They are low fixed capital investments and are relatively easy to construct with low annual running costs
- Suitable for crops such as onions, Swedes and beetroot for the wholesale and supermarket trade
- Carrots and cabbage can be stored this way for direct marketing outlets
- Potatoes will only store in clamps without sprouting until Jan/Feb

Box Storage

- Requires higher initial investment but is often more suitable than bulk storage
- Practical way of keeping crops separate within the same store
- Storage rots are likely to remain localised within particular boxes
- Boxes can be removed from the store as required and damage during handling can be minimised
- Boxes can be tailored to quantity of produce available and can range from large pallet boxes to crates and cardboard boxes of various types
- Crops that are suitable for storage in clamps can also be stored in pallet boxes
- More delicate produce can be stored in smaller crates or cardboard boxes

Ambient air-cooled stores

- Modified and highly insulated stores that have fan assisted ventilation can provide relatively cheap and more reliable storage particularly for larger tonnages of most hard vegetables that require winter storage
- Greater price premiums must be achieved to give satisfactory return on the amount of capital invested
- Produce is generally stored in boxes or sacks within stores but in such a manner that airflow can be maintained

Refrigerated storage

- This involves a much increased investment and higher running costs
- They can maintain produce in better condition for a longer period of time than ambient temperature stores
- Use of refrigerated containers offers a lower cost alternative for individual growers who might have smaller quantities of produce. These can be bought second hand or reconditioned
- Refrigerated cold stores can allow rapid cooling of produce which helps maintain quality in perishable crops
- Produce would again be stored in boxes, crates or sacks within the stores but it is vital that airflow be maintained around containers to enable them to quickly attain and maintain low temperatures to prevent moisture build up around produce

Long term cold storage

- This is possibly the most expensive option and will require a premium from selling off-season produce
- Economies of scale exist for larger stores and for small producers point the way towards co-operative ventures in storage

Controlled atmosphere storage

- It is possible to control vegetable or fruit respiration by reducing the oxygen content of the air and increasing carbon dioxide and/or nitrogen content
- It is also possible to delay maturation and senescence by removing ethylene from the air in-store
- In the future this developing technology will be useful for prolonged storage of several vegetable crops
- It is currently permitted in EU and IFOAM standards only

Mixed storage

- Useful where growers are producing small quantities of a wide range of crops and need to keep them in the same store

- There is little published information on long-term storage of different crops together
- However, organic growers have seen success with potatoes, carrots, onions and cabbage in refrigerated storage
- Cross transfer of odours might be a problem in some situations and storage conditions will be a compromise between the conditions required for each individual crop

Avoiding Storage problems

- Storage problems can be avoided by planning the crop cycle and harvested quantities to coincide with demand periods. That way it is only necessary to harvest, handle and market fresh produce
- You should choose varieties that are known to travel well and have a long shelf life
- Disease free seed should be used and care taken to prevent pest and disease attack in the field
- Avoid oversupply of nutrients and undersupply of others e.g. calcium
- Erratic irrigation should be avoided to prevent skin cracking on vegetables.
- It is important to harvest produce at the correct time and under the appropriate weather conditions
- You should not harvest in the rain as this can cause drying problems and the risk of storage of wet crops
- If you are harvesting when it is sunny then produce should be rapidly transferred to a cooler location
- Careful handling is vital at harvesting particularly when grading the produce
- Methods to minimise handling include
 - harvesting, grading and packing in the field
 - on mobile rigs
 - grading by hand is usually more gentle than mechanical grading
- Crops which are to be stored should be free from skin damage, bruises, spots and rots as all these things can lead to moisture loss and poor appearance
- When trimming and cleaning vegetables at least some debris can be left to protect or cushion
- When stacked crates should not be overfilled as this would allow the produce to fall out or be crushed

3. Examples of individual crop requirements

Potatoes - can be stored in heaps or sacks, avoiding all light.

Onions-Once fully dried onions still need air circulation and it would be unwise to heap them up without forced ventilation. They can be kept in well-ventilated nets, crates or trays at this stage.

Roots - are liable to damage from desiccation. These should be bagged or otherwise covered in a way that allows for some gaseous exchange but without excessive loss of moisture. They should not be surface wet when going into store. Carrots, particularly if unwashed, will keep satisfactorily for several weeks in closed paper sacks. Parsnips are best off in the ground but can be kept 2 to 3 weeks in sacks, although the skins will discolour. Beetroot is prone to drying out and wizening, and the moister atmosphere provided by woven plastic sacks suits it better than paper. Celeriac resists drying out and is inclined to go slimy if sealed. It keeps well in crates or open bags, and should be harvested (before hard frosts) in such a way that it can be re-trimmed before packing.

Cabbage - White and red cabbage should be harvested before damaging frosts and will then keep until March in ambient conditions, though 0 to 1 °C and 95% RH is ideal.

Pumpkins and squash - need good air circulation and a temperature of at least 7 °C. if they are to store much beyond Christmas. A frost-free space, without marked temperature fluctuation, is sufficient for storage of 2 to 3 months.

Top Fruit - Storing top fruit for any significant periods requires proper chilled storage facilities, with control of CO₂ levels and ventilation. The condition of the fruit when it goes into storage is vital. Some growers opt for juicing and bottling excess fruit to provide an income throughout the year rather than investing in fridges.

Further reading:

Organic Vegetable Production, Gareth Davies and Margi Lennartsson

Farm Machinery, Brian Bell

Horticultural Machinery, Brian Bell and Stuart Cousins

Controlled Atmosphere Storage of Fruits and Vegetables, A.K. Thompson

Root Cellaring: Natural Cold Storage of Fruits and Vegetables, Mike Bubel and Nancy Bubel

Handbook of the Diseases of Vegetables Occurring Under Market, Storage, and Transit Conditions, George K. K Link