Ware potato harvesting and storage techniques

Guidelines for harvesting and storage management of ware potato

Expanding Utilization of Roots, Tubers and Bananas and Reducing Their Postharvest Losses

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**INTRODUCTION**

Potatoes are commonly regarded as a bulky, perishable commodity with high transport costs and limited export potential, confined mostly to cross-border transactions. The potato is a good source of dietary energy and some micronutrients, and its protein content is very high in comparison with other roots and tubers. Fresh potato consumption is the major form of utilization, however processing has improved to meet rising demand from the fast food, snack and convenience food industries. The growing urban populations, rising incomes, the diversification of diets and lifestyles is the driver behind this new development.

Potato in Uganda is considered both a cash and food crop in the limited production areas. It has the ability to lift citizens out of poverty. Despite its potential, intensification levels remain very low in the potato subsector, translating into a very low yield. Farmers increase production by expanding the land used to grow potatoes, not by intensifying their activity. This results into poor quality yields and thus losses in income at the household level. More land would require efficient and effective use of resources. Serious losses occur postharvest stages, especially during harvesting and storage. Some of the losses result from bruising, improper curing, weight loss and starch breakdown. The causes of postharvest losses at storage include sugar buildup, decay, sprouting and greening (chlorophyll development).

Harvesting the potato crop is a critical part of the entire potato production and marketing operation. Crop yield and quality cannot be increased during harvest, but they can be decreased, sometimes dramatically. Harvesting methods in Uganda are still very rudimentary using mainly household and manual labor with traditional hand-hoes or special sticks. The use of improved methods of harvesting would reduce damage and drudgery during harvesting. Furthermore, storage of the harvested tubers for longer periods would allow the producer to access a more stable market and therefore better prices for good quality potato. This guide therefore gives the basic principles for potato harvesting and storage to ensure good quality ware potato for enhanced market access and better prices.

**POTATO HARVESTING**

**2.1. Field management**

The principal cause of quality loss occurs by not observing proper procedures during harvest. Certain cultural practices, such as excess nitrogen, excess water, and poor soil aeration, can predispose tubers to the development of more severe damage. However, most of the actual damage occurs during digging, loading, and transporting operations. The time of harvesting depends on the varieties grown. Potato crop should be planted with a marketable variety of known maturity period. The crop should be planted at correct spacing of 70 by 30cm and ridges of 25-
30cm height (Figures 1, 2 & 3). The crop should be uniform, pest and disease free with no abiotic stress.

Figure 1: Well prepared field with ridges ready for potato planting

Figure 2: Potato plants planted at interplant spacing of 30cm to maximise tuber expansion
2.2. Dehaulming

Potato is said to be mature when 75% of the foliage/vines are drying out or turn yellow. At this stage, the action of dehalming should be conducted. The simplest way to detect maturity is to dig up random tubers, check if the size is marketable and rub the skin with your fingers. The tubers are mature if the size is above 60mm diameter or of a marketable size and skin does not peel off easily (Figure 4).

Dehalming is the practice of cutting of haulms/aerial parts by sickle or destroying by machines when the crop attains 75-90 days or when physiological maturity is shown by aerial part of the plant turning yellow (Figure 5). The crop should be harvested 10-15 days after haulm cutting/dehaulming.

Dehaulming can also be done ahead of harvesting in case of late blight susceptible varieties to avoid late blight infection on tubers, the crops is dehaulmed when just 20-25 % of foliage is killed by late blight.
Figure 4: Field testing of maturity by rubbing randomly selected tubers between fingers (A) Immature if skin peels and (B) Mature if skin doesn’t peel

Figure 5: Slashing potato vines with cutlass/slasher to improve maturity (dehaulming)
2.3. Field harvesting conditions

Potato should never be harvested when the weather is too wet or too dry. The soil should be moist but not wet/dry. The dry soils have clods that are very abrasive, causing tuber skinning and bruising during the harvest operation. It is best to harvest when the weather is cool and not too hot or when the day is nice and sunny.

Vines can cause mechanical difficulties in the digging operation. They can host certain insects and diseases which, if not removed, will come in contact with the tubers during harvest. Whether chemicals or natural senescence has caused the death of vines, it is worthwhile to eliminate the vines from the top of the beds. This can be accomplished by using manual labor to collect them although mechanical shredders or beaters would do best.

2.4. Potato harvesting using hand hoes/sticks

Hand hoe harvesting should not be used because it will result into more damaged tubers, takes a lot of time and many tubers are left underground. A better tool to use, if other options are too costly is, the garden fork which causes less damage to tubers than the hand hoe (Figure 6). This approach should only be used initially for sections with high bacterial wilt incidence to avoid mixing potentially diseased potato with healthy potato at the end of harvesting exercise. These tubers should be packed separately and taken for immediate consumption.

Figure 6: Harvesting of potato using a garden fork (best for spot harvesting)
2.5. **Potato harvesting using animal drawn digger**

The rationale for using oxen drawn tools for cultivation and transportation is that it increases agricultural work output, reduces drudgery and improves life in rural areas. Compared to other means of modern agricultural production, animal traction is the one that a smallholder can think of eventually possessing. Potato producers can use the animal drawn potato digger to harvest potatoes on large scale. These diggers are pulled by a pair or two of oxen, driven through the field to expose the tubers on top of the ridges for ease of picking. Less human labor than hand hoe harvesting is needed for this harvesting method. The animal drawn digger is faster and results into less damage and also exposes more of the tubers in a field (Figure 7). Locally a producer should use plough frames on the farm, modified by removal of the mouldboard and replacing with a forked end. These can be accessed at Agricultural Engineering and Appropriate Research Centre (AEATREC), NARO. It will work best for a farm in which potato was planted in lines thus following a ridge is much easier. This option is much cheaper even if a producer purchased a full set of plough and harvester.

*Figure 7: Harvesting ware potato with an animal drawn lifter/digger*
2.6. Potato harvesting using tractor drawn digger

The tractor drawn digger comes in a variation of single or double rows. These are attached to the three point linkage of a small tractor and then connected via a shaft to the digger set. The potato digger unit should be aligned along the ridge and adjusted to cut at base of the ridge. The speed of the shaker should also be adjusted via the tractor's power take-off (PTO) such that it gently shakes off the soil and delivers the tubers on top of the ridge (Figure 8). The tractor should be aligned such that the tires run along the furrow to avoid compression damage of the tubers. The tubers are then picked up by hand and placed in a collection bin for transportation to the storage yard. This system is much faster, more efficient and less damaging to the tubers compared to animal drawn digger.

Figure 8: Harvesting potato with tractor drawn digger/lifter along the ridge
2.7. Potato sorting, grading and drying/curing

Harvested potato should be carefully transported to a storage yard for sorting, grading and curing prior to storage. Damaged and diseased potato tubers should be sorted out and disposed off. The remaining tubers should be graded into marketable (tubers size >60mm, even shape, healthy) and un-marketable tubers (Figure 9).

The marketable potato should always be dried quickly to remove excess moisture from the surface of tubers for improving their keeping quality. This should always be done in a storage shed, exposure to sun causes the greening of the tubers. Do not store the tubers immediately if they were exposed to rain during or after harvest.

![Figure 9: Sorting and grading of ware potato](image)

Always follow the curing process at 25 degree centigrade with a 95 per cent relative humidity. For optimum suberization (formation of a protective layer between the tuber surface and the interior tissue), curing is essential for healing the wounds of tubers resulted from cutting and bruising during harvesting. During this time, potatoes become more resistant to storage diseases and shrinkage.
WARE POTATO STORAGE

Ware potatoes can be stored up to six months in tropical highlands without significant losses provided that: the variety of potato is one with a long dormancy; the potatoes are free from diseases, damage or insect infestation; storage temperatures are kept to levels that do not induce high rates of respiration and the relative humidity within the store is kept at sufficiently high levels to reduce water loss from the tubers and the potatoes are not wet as a result of rain or condensation.

Storage is defined as that stage in the agricultural cycle aimed at preserving or holding crop produce through time until it is ready to be utilized, consumed, exchanged, or released onto the market.

Proper storage at households or communities involves technical aspects because the physical place has, ideally, characteristics of design, construction, and management which aim to reduce losses and promote security. It is also aim at economic gains because it regulates the movement of the produce in time, in accordance with market demand or the demands for consumption by the farming household. Storage is influenced by socio-cultural beliefs because storage decisions are made by the household, and sometimes, by traders, communities, or nation states. The use of household space, architecture, exchange networks, and gender issues including variables such as patterns of home consumption, family size, architecture of the house, and folk beliefs can characterize storage decisions.

3.1. Small-scale short-term storage options

3.1.1. Pit storage

In eastern Uganda Katchha pit is rectangular in shape and measures 4.5 x 3.6 x 14m while Pucca pit is normally circular in shape with a diameter of about 4.2m. The ware potato in pits are covered with 0.3m thick of available straw material (wheat, barley, rice, grasses) as shown in Figure 10.

3.1.2. Room in house

Make small special rooms built of brick /stones near the residence. The potatoes are stored in heaps, gunny bags or in bamboo baskets (Figure 11). The bamboo baskets provides better aeration to the tubers. The smallest size holds 10 -12Kg and the largest size 100Kg potatoes.

3.1.3. Clamp storage

Dig a trench in the ground and heap tubers on a bed of straw 1m to 1.5m wide. Insert a ventilating duct on the floor in the center of the heap and cover with a layer of about 20cm of compacted straw or 30cm if not compacted. The clamp must be in a well-drained location.
Figure 10: Potato stored in pits within the field with a dry straw base for short term storage

Figure 9: Ware potato packed in bags for very short term storage in house
3.1.4. Improved wooden store
Construct a store of 5 by 4 by 3.5m using strong poles and tightly cover the walls with planed timber to minimize light (Figure 12). The floor is made of strong timber frames with spacing of 5cm between the struts. Attach a rat proof netting such as expanded metal on the floor. A false ceiling can be placed before the corrugated iron roof with a layer of straw for the warmer areas. A ventilation window facing the common direction of wind is placed at the top corner of the roof. This window is only opened at night to let out warmer air from the store. The walls should be lined with papyrus mats to further minimize light in the store.

3.2. Improved ambient potato storage
A large-scale modern facility for long-term storage (around 3 months or more) designed to control air temperature and relative humidity using natural weather. It is made of compressed straw bales, strong timber strut frames on a metal super structure and sits on a re-enforced gabion foundation. This store has a capacity of 600 bags or 60tonnes of ware potato. A wind vent is fitted at the corner opposite the door to enhance ventilation control. The floors are made of strong timber struts covered with expanded metal to reduce rat damage while allowing floor ventilation. All walls are plastered with cement to protect the straw from rodent and weather damage. A corrugated iron roof on a timber pole frame should be placed to cover the ambient store (Figure 13).

3.2.1. Management of conditions in ambient store
The wind vent should be opened at night to allow sucking out of warm air while cool air enters through the floor and gabion. The wind vent is closed during day to retain the cool night air inside the store. Humidity should be monitored and if it lowers buckets of water should be placed on the floor of the store. The store should never be opened unnecessarily to maintain the ambient conditions. Potato should be monitored regularly for any quality deterioration and either lots sold off or discarded as may be guided by the store management. The temperature should be kept at a range of 7-10°C and relative humidity of 95-98%.
Figure 102: Above: external outlook of improved wooden ware potato store and below: ware potato parked in bags inside the store
3.3. Loading stores

Loading the store should be an activity which is planned well in advance of harvest. It is important to match crops, in terms of their quality, likely storage periods and market expectations to the storage available, so that management is effective and returns are maximized. Potato should be stored such that there is free flow of air through the tubers to minimize heat buildup which can

Figure 113: Above: External outlook of ambient ware potato store with vents and iron-sheet protective roof and below: ware potato in chambers within and ambient ware potato store
result into soft rots. The loading should ease the movement through the store for monitoring quality and also off-loading of the store. The potato can be loaded into stores in jute bags but not polythene sacks. In this case stacking should not be of more than two bags on top of each other. The potato can also be loaded in wooden crates of 100Kg capacity or chambers of 500Kg capacity (Figure 14). Crates allow for easier stacking and more than 10 crates can be packed on top of each other thus optimizing space. Heaping on the ground is not encouraged unless the store will be loaded once and then fully off-loaded after a specific period.

3.4. Pest and disease management

The potato tuber moth is one of the most devastating pests for potato in storage. The larvae penetrate the tubers mainly at the eyes, after which they tunnel under the skin and deeper tunnels are formed in the tuber over time (Figure 15). Use pheromone traps to monitor the levels of moth infestation before deploying chemicals in store.

Disease control is a fundamental component of storage management. Most diseases do not originate in store. However, many of the disease problems affecting the marketability can develop to some degree in store and, if not controlled, the consequences can be catastrophic, either in terms of physical breakdown of the crop or in loss of market value. Therefore stored potato should be monitored regularly for any signs of silver scurf, black dot, skin spot, dry rot and soft rot.
3.5. General store management

A store management committee with a quality control manager must be in place to oversee general management of the store. A clean store, free from discarded tubers, dust and debris should be maintained. It will minimize crop infection, improve air flow, contribute to worker health and comfort, and is likely to impress clients and customers.

Good store management should ensure that temperatures and relative humidity are measured both internally and externally. This has a bearing on the efficiency of the store and optimum management of temperature and relative humidity.

Crop monitoring and regular sampling and assessment of the stored crop is vital to optimize storage conditions, minimizing storage problems and monitor the effectiveness of store management. It will also save time and money by avoiding rejections of tubers and price discounts.

Quality should be ensured through good record keeping which allows to quickly identify weak points in a storage system. Record keeping should be designed so that all information on a batch of potatoes is kept together. Reasons for any problem can then be rapidly identified. All action taken should be recorded on the log for a batch. A store diary is important to keep record of general store management information related to all the stocks held within the store. This will include major events such as loading, ownership, crop type, conditions, and chemical application, regular store inspections for rots or diseases and sales transactions.
Annex 1. Summary guidelines for ware potato storage

**ONLY STORE THE BEST POTATOES**

**Storing quality potatoes begins in the field during the growing season**

- Only store good quality potatoes. If any potatoes are rotting, damaged or coming from diseased fields, these potatoes must be eaten or sold at harvest.
- Storing only a few rotten potatoes can result in great losses in storage.
- During the growing season, mark areas infected with bacterial wilt to avoid storing potatoes harvested from these infected areas.
- Do not store potatoes from plants infected with bacterial wilt, these potatoes should be sold right after harvest.
- Do not store potatoes that have been damaged during harvest or are starting to rot, these potatoes should be sold right after harvest.

![Potato infected with bacterial wilt](image1)

**Harvest practices for better storability**

- Only store potatoes harvested from mature plants.
- De-haulm plants 10 – 15 days before harvesting.
- De-haulming is killing the plant above the soil – usually by cutting the stem at the soil line.
- De-haulming is essential if potatoes are to be stored as this allows the skin to thicken to protect from handling and transport injury, as well as postharvest diseases.
- De-haulm during dry conditions.
- Harvest potatoes gently, most injury to potatoes occurs during harvest.

![Potato plants after de-haulming](image2)

**In case of late blight infection**

- If a crop shows symptoms of late blight it is important to avoid storage of the potatoes becoming infected with late blight.
- De-haulming will assist to stop potatoes from becoming infected with late blight.
- If a crop is infected with late blight, de-haulm when 20 – 25% of foliage is killed by late blight.
- Potatoes infected with late blight can rot in storage.

![Potato infected with late blight](image3)
HOW TO STORE POTATOES INSIDE THE STORES

➢ After following the good practices of the previous page, it is still important to select good quality potatoes for storage and remove all rotten, damaged and diseased potatoes
➢ DO NOT STORE ANY POTATOES SUSPECTED OF BEING ROTTEN, DISEASED OR DAMAGED
➢ Keep potatoes in the dark to slow down sprouting → exposure to light promotes sprouting
➢ Monitor stored potatoes regularly and remove all rotten potatoes and those adjacent to any rotten potatoes

Crates

➢ Store in crates if possibility of rotten or damaged potatoes. Thus if some potatoes are rotten the crates will limit the spread of rot to more potatoes in the store
➢ Crates also make it easier to trace when different harvest lots are put in the store
➢ Suitable for long term storage, 2 – 3 months

Bulk

➢ Potatoes can be bulk stored if all potatoes are of good quality and there is low risk of a few rotten potatoes creating a rotten nest in the middle of the piles
➢ A bulk pile up to 2 m in height
➢ Bulk piles can be right up to the walls, no need to leave a space between the pile and a wall
➢ Bulk piles are suitable when it is not necessary to trace certain potatoes to a harvest lot or owner
➢ Suitable for long term storage, 2 – 3 months

Bags

➢ Potatoes should only be stored in bags for short term storage, maximum to 3 weeks
➢ Store bags upright, not on their side
➢ Only store good quality potatoes in bags
➢ Bags restrict air flow thus if a rotten potato is in the bag, the remaining potatoes can rot quickly

Contact BUGIZARDI for more information +256 782 427 527
Annex 2: Structural design of improved ware potato store
Annex 3: Structural designs of improved ambient store