



BASIC TECHNICAL GUIDELINES FOR THE **HARVEST, PACKAGING** AND **STORAGE OF** **POTATOES**

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Even after harvesting,
the tubers remain
alive and require
appropriate
treatment.

Efficient potato
storage leads
to increased
profits.



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In **potato** cultivation, the focus isn't on the fruit but rather on the tuber, (the thickened underground part of the plant). Once harvested, tubers exhibit similar traits to fruits; they remain alive, respire, emit moisture, and eventually sprout or deteriorate. We aim to generate high-quality tubers, promptly remove them from the soil, store them adequately, and transport them to the market.

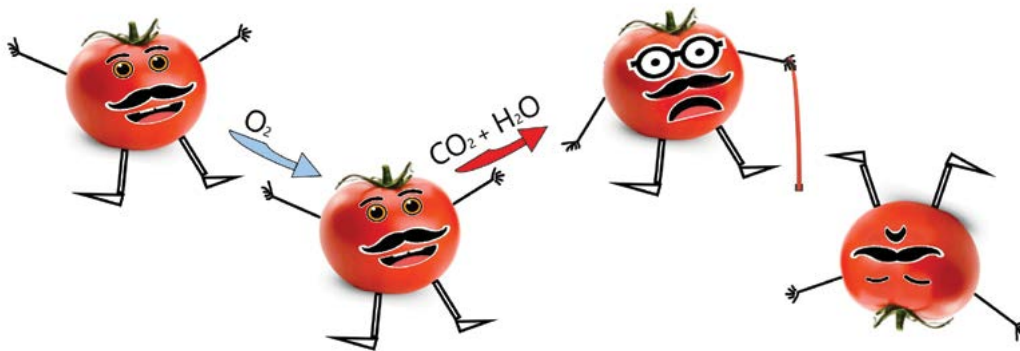


Figure 1: A shared feature among all fruits is their ability to persist in living post-harvest, even after being separated from the plant. This also holds for the thickened underground part of the potato rhizome, the tuber. Once removed, tubers respire, emit moisture, undergo shrinkage, age, and eventually deteriorate entirely. Understanding these processes is crucial to slow their pace and maintain the product in a market-acceptable condition for an extended period.



HARVESTING – DIGGING UP POTATOES

The timing of potato harvesting relies on various factors, primarily the potato variety and the technological maturity of the tubers. It also depends on the producer's preference, whether to supply new or old potatoes to the market. New potatoes aren't fully technologically mature, yet they fetch a higher price. Hence, producers, considering market conditions, decide whether to harvest new potatoes, yielding less per unit area but a higher price per kilogram, or wait for complete tuber maturity, resulting in a higher yield but potentially a lower price per kilogram.

When harvesting new potatoes, the ideal moment is when the majority of individual tubers weigh over 20g or 200-300g potatoes per furrow. It's important to note that new potatoes lack developed tough skin, so washing them is discouraged. Instead, after harvesting, they're stored briefly and swiftly dispatched to the market (washing damages the outer layer, causing faster moisture loss and shrinkage in the tubers).

If potatoes are produced in the stage of full maturity, the digging begins when the above-ground part of the plant has fallen over. This signifies the completion of the nutrient transfer into the tubers, the skin has fully developed and the tubers can be easily detached from the stolons.

Potato harvesting methods depend on their degree of automation: manual harvesting, semi-mechanized harvesting, and mechanized harvesting.

Manual harvesting is done on smaller areas and entails manually digging up the tubers using appropriate tools, followed by their collection, packing, and storage. Tubers are commonly stored in bulk, typically in cellars or storage pits. This method of harvesting and storing potatoes is typical of extensive farming practices.

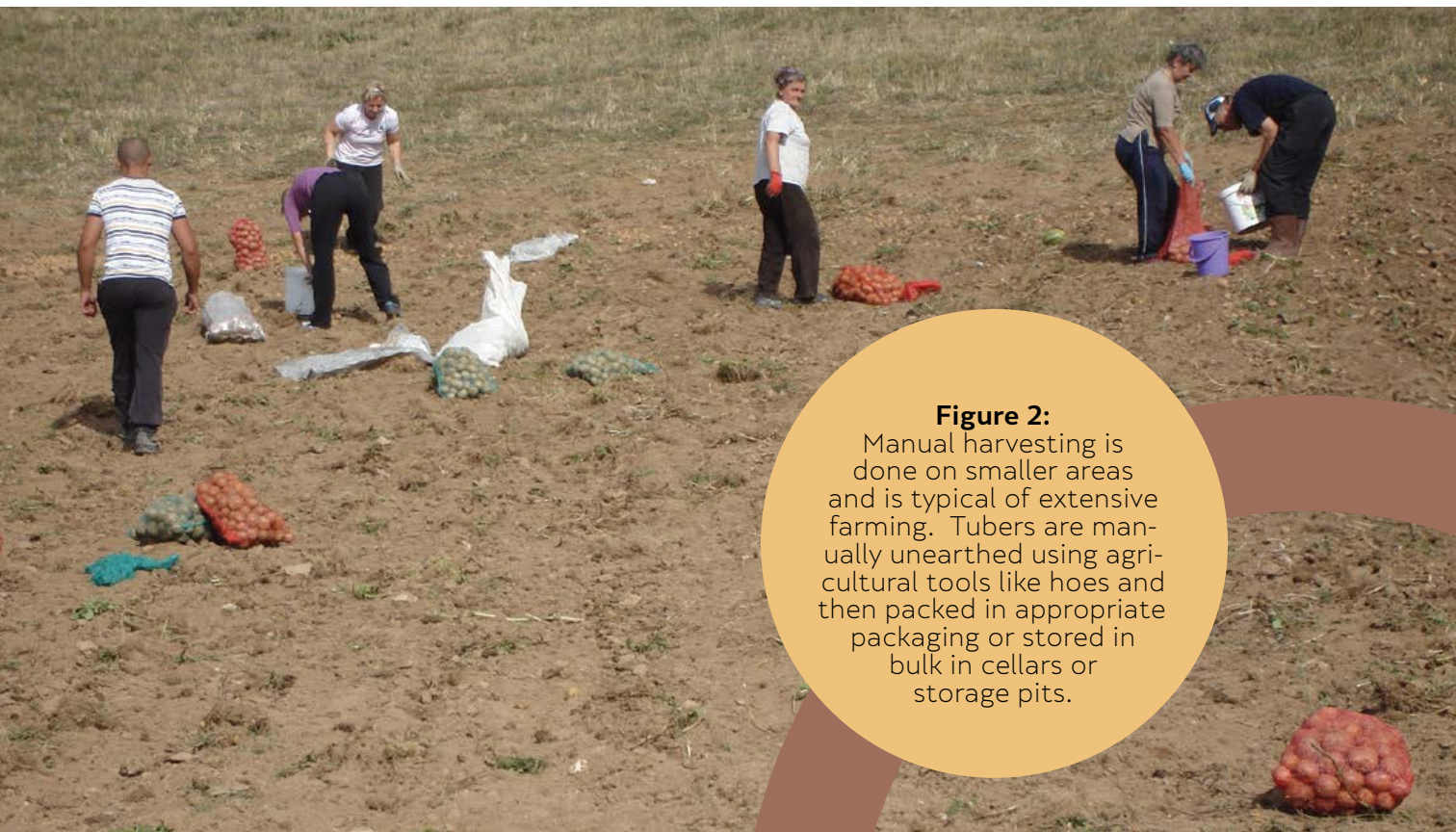


Figure 2:

Manual harvesting is done on smaller areas and is typical of extensive farming. Tubers are manually unearthed using agricultural tools like hoes and then packed in appropriate packaging or stored in bulk in cellars or storage pits.

Semi-mechanized harvesting combines the use of machinery for digging up tubers with manual collection and bagging. It is the so-called two-phase harvesting system: the first phase involves unearthing the tubers with potato harvesters followed by hand collection of the unearthed tubers in the second phase. This approach is prevalent in our fields for harvesting potatoes.



Figure 3: In our circumstances harvesting–unearthing potatoes typically involves a two-phase process: the initial phase employs potato harvesters (on the left) to dig up the potatoes, while the subsequent phase involves hand-collecting and bagging the tubers (on the right).



Mechanized potato harvesting involves machine-based digging and gathering of tubers without the involvement of human labor (except for machinery operators). Mechanized harvesting can be single-phase or two-phase. In the first scenario, tubers are dug up and collected using the same machine in a single pass. In the two-phase system, the first machine digs up the tubers, while the second one gathers them into tractor-trailers.

The tubers are gathered right after harvesting and moved to storage promptly. Prolonged exposure of tubers to sunlight post-harvest triggers chlorophyll pigment

production, causing the tuber skin color to shift from brown to green. This chlorophyll synthesis also brings about the alkaloid solanine, indicating higher solanine levels when the tubers turn green. Elevated solanine levels in potato tubers pose health risks to humans.

Figure. 4:

Machinery, typically harvesters, is used for mechanized potato harvesting (unearthing), commonly completed in a single pass (known as single-phase harvesting). <https://www.potatonewstoday.com/>





Figure 5: Prolonged exposure of tubers to sunlight post-harvest triggers chlorophyll pigment production, causing the tuber skin color to shift from brown to green. This chlorophyll synthesis also brings about the alkaloid solanine, indicating higher solanine levels when the tubers turn green. The image displays the change in color of tubers exposed to light for a duration of 6 days at a temperature of 20°C.

During the process of unearthing the tubers, machinery causes damage to the tubers. During collection, those tubers are discarded or collected and used as animal feed.

If there are minor injuries and bruises on the potato tubers after harvesting, they will heal over time. It is preferable to keep the tubers in a dark place at temperatures around 15°C for two to three weeks after harvesting to ensure the healing process of the wounds is completed properly. After that, the tubers are stored at lower temperatures.

After harvesting and gathering, the potatoes are packaged in the containers used for market delivery and remain stored until they are sold. Under our circumstances, we typically use mesh bags for this purpose, stored in dark rooms and dispatched to the market as required. Alternatively, the potatoes are stored in bulk in ground-level warehouses and only bagged right before being delivered.



Regardless of the packaging type, the content must be uniform—meaning the packaging should hold potatoes of identical variety, class, origin, and organoleptic traits. The packaging must be clean and made of materials that cannot damage the tubers, transmit foreign odours, or in any way negatively affect the quality of the packed tubers. It's essential for the packaging to be clean and crafted from materials that won't harm the tubers, transfer foreign odours, or compromise their quality. Ventilation of the tubers must be ensured because in the absence of oxygen, internal browning of the tubers occurs.



Figure 6:

Under our circumstances, after harvesting, potatoes are commonly packed into mesh, plastic, or jute bags. These bags are then stored in warehouses or basements until delivered to the market.



Figure. 7:

Potato tubers, delivered in bulk from the field, are first shaken off onto the sorting line (on the left) and then carried by moving belts or conveyors for further processing (on the right) along the sorting and packaging line.



When dealing with larger potato producers, the potatoes are typically harvested using harvesters and transported in bulk to sorting facilities. There, they undergo washing, sorting, and packaging into various containers.



During sorting, damaged, blemished, wrinkled, or sprouted tubers are separated. Only healthy tubers with normally formed skin and no damages are directed to storage (or directly to the market). The tubers should not have altered skin color or any odors indicating rot.



Figure 8: When moving through the sorting and packing line, the tubers are washed with a jet of clean water (on the left) and then proceed to sorting, which is done on rollers or sieves (on the right). The smaller tubers fall through the sieves or the spaces between the rollers, while the larger ones are retained. By adjusting the distance between the rollers, it's possible to regulate the size of the tubers that pass through and consequently the number of classes.



Figure. 9: The sorted tubers are automatically packed either in plastic bags (on the left) or cardboard boxes (on the right). The packaging is connected to a scale, and tubers are funnelled into it until it reaches the desired weight. Once the required weight is reached, the full packaging is replaced, and the empty one takes its place. The entire process is fully automated, minimizing the human role in supervising the machine operations.

POTATO STORAGE

Before storing the tubers, they undergo preparation, starting with drying in shaded and ventilated rooms or in purpose-built dryers. Inadequate tubers are separated before the storage process begins. Tubers can be stored in bulk within floor storage rooms, boxes, or containers. Additionally, there's the option to store potatoes in various types of packaging such as plastic, cardboard, or wooden containers, which are used for direct delivery to the market.

If potatoes are stored in bulk in floor warehouses, it is necessary to provide sufficient space without overcrowding. Considering an approximate storage capacity of 0.6 tons of tubers per cubic meter, a decision should be made about the total stored quantities in a certain space. The maximum pile height of 4 meters is for tubers and for seed potatoes must be lower than 4m.

Potato tubers have a reasonable shelf life in standard warehouses. However, their storage duration significantly extends when kept in cold storage facilities with either a normal or controlled atmosphere in which the oscillations of the storage parameters are minimal.

Regular potatoes are stored at temperatures ranging from 5 to 10°C with a relative air humidity of about 90%. In the case of seed potatoes, the storage temperature should be around 3°C, with a relative air humidity of about 90% (seed potatoes are kept in dark rooms to slow down sprouting, but just before sending them to the market, they can be kept outside these dark rooms to initiate sprouting). Losses in the mass of potatoes during storage range from 5% in cold storage facilities to 15% in regular warehouses. Tubers can be successfully stored for 8 to 10 months, depending on the storage conditions

During the storage of potato tubers, various disorders affecting their quality may occur, such as the appearance of diseases, internal darkening, wrinkling, sprouting, and others.





On potato tubers, various diseases can occur during storage, with the most common being dry and soft rot, blight, scab, and others. The appearance of rot often accompanies a strong, unpleasant odor, prompting the need to regularly check and remove stored tubers from the storage area to prevent the spread of diseases. These diseases can be prevented through proper agricultural practices and crop protection during the production process. Fungicide treatment after harvesting the tubers is permitted only for seed potatoes.

A significant problem is also the appearance of discoloration of the interior of potato tubers, often resulting from low temperatures (freezing) or a lack of oxygen (or excess carbon dioxide) within the storage area. These changes aren't visible on the surface of the tuber but become apparent only upon cutting, making them more difficult to detect during storage.



When damage from low temperatures occurs, the inside of the potato tuber takes on a yellow or brown color without a clear boundary between healthy and damaged tissue. That is why potatoes should not be stored at temperatures lower than 3°C to prevent this type of damage.

The presence of a purple or black color within the tuber, along with a clear boundary between healthy and damaged tissue, suggests insufficient oxygen and a disruption in tuber respiration. That is why regular checks during storage are essential, involving the cutting of tubers and if changes in the tissue are detected, adjustments to storage conditions are made, such as raising the storage temperature or ventilating the warehouse, depending on the specific disorder observed.

One of the major challenges during the storage of potato tubers can be their sprouting, impacting the overall tuber quality and the possibility of placing them on the market. To deter sprouting, proper storage conditions prove effective—lower temperatures notably reduce the likelihood of sprouting or chemical solutions to thwart sprouting during storage (so-called sprout inhibitors). These inhibitors come in various types, applied through methods such as plant spraying during growth, dusting of harvested tubers, or fumigation of stored potatoes. It's imperative to adhere closely to manufacturer guidelines when using sprout inhibitors, as their incorrect application could potentially impact consumer health.

