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On-Farm Management of Cull Potatoes

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Introduction

CULL POTATOES ARE TUBERS that are unusable for fresh market, processing, or dehydration because they do not meet minimum size, grade, or quality standards or they are disposed potatoes due to low market value associated with overproduction. Cull potatoes may accumulate any time during the year:

- At planting, potato waste material may accumulate when seed potato pieces or seed tubers are discarded due to size (e.g., slivers) or disease problems
- At harvest, potatoes that do not make grade due to size, disease, or defects are sorted and discarded prior to placement of the crop into storage
- Any time potatoes are removed from storage, those that are diseased, damaged, not within a desirable grade, or in oversupply are culled and discarded
- Year-round at fresh pack and processing operations

For these reasons and because cull potatoes are produced at many different times and locations throughout the state, dealing with proper disposal can be challenging, especially in years when they are particularly abundant. In addition to being a source of plant diseases, insects, and weeds, improper management of cull potatoes and associated dirt and plant debris leads to other undesirable consequences, such as rotting and decomposing cull piles that produce odors, attract insects, and provide a point source for nutrient leaching into ground and surface waters.

Disease, Insect, and Weed Concerns

Cull potatoes can be sources of plant pathogens, such as those that cause late blight, mosaic, net necrosis, bacterial ring rot, and other plant diseases. They allow insect pests such as flies and fruit flies to increase in numbers and they harbor

plant parasitic nematodes. Sprouting cull piles can host aphids and psyllids. Soil associated with cull potatoes may be infested with soilborne pests and plant pathogens such as the powdery scab pathogen, plant parasitic nematodes, and weed seeds. Thus, cull potatoes, if not managed properly, can create volunteer potato problems in other crops (see Risk of Volunteer Potatoes for more information about volunteer potato management in these situations).

Cull potato and debris management has become a vital part of any potato production operation, particularly because of the risk of late blight, caused by the fungus-like water mold *Phythophthora infestans*. The late blight pathogen survives in infected cull potatoes and forms spores on infected tubers, sprouts, or foliage. Spores can be produced in abundance from cull piles (Figure 1) and moved by the wind to potentially initiate a regional epidemic if weather conditions are appropriate for late blight development.

Figure 1. Cull pile, with soil and sprouting potato tubers.

Potato viruses survive in infected cull potatoes. Although Potato leaf roll virus (PLRV) has been a virus of concern, seed potato growers are more recently concerned with Potato virus Y (PVY), a virus readily found in cull piles potentially at high incidence (>50%, based on a recent survey conducted by the University of Idaho). Both viruses are vectored by aphids. When cull potato tubers sprout, the resulting foliage can become a host for aphids and other insect pests. If the cull potatoes are infected with a virus, the aphid vectors may acquire and move the virus to healthy plants in adjacent potato fields.

Soilborne plant pathogens, such as the powdery scab pathogen, survive as resting spores in soil associated with cull potatoes or in the tubers themselves. Similarly, plant parasitic nematodes also survive in soil or tubers associated with cull piles. Thus, if handled improperly, infested soil or tubers can contaminate fields previously free of these types of pests and pathogens.

Groundwater and Surface-Water Contamination and Nuisance Situations

Cull potatoes provide a significant supply of nutrients, so avoid placing cull piles in areas where either groundwater or surface-water contamination can occur. To prevent potential surface-water contamination, avoid disposing of cull potatoes near point water sources such as irrigation ditches, springs, ponds, lakes, and streams. A decomposing pile of potatoes can also be a significant nuisance due to its offensive odors and the inevitable presence of flies and other undesirable insects. Select a disposal site and method that will not allow discarded potatoes to become a public nuisance.

Cull Potato Management Is Required in Idaho

The Idaho State Department of Agriculture (ISDA) requires cull potatoes from all potato operations to be rendered nonviable on a daily basis after April 15 in the Magic and Treasure valleys (west of Raft River) and after May 15 in the upper Snake River valley of eastern Idaho (east of Raft River). This rule continues through September 20 and is in place to help eliminate a potential source of problems for the current season crop and to aid in maintaining the integrity of Idaho's potato crop production and quality. Cull disposal must be accomplished in an environmentally safe, legal, and effective way. For further information, contact the ISDA, Idaho Division of Environmental Quality, or your local district health department office. More information on the rules governing the disposal of cull potatoes can be found at https://agri.idaho.gov/main/plants/potatoes/.

Options for Cull Potato Management

1. Winter field spreading
2. Burial
3. Livestock feed
4. Compost
5. Chemical applications

1. Winter Field Spreading

One option for disposing of cull potatoes is to spread them on top of the soil. Of course, avoiding fields that will be planted to potatoes is important because cull potatoes and associated soil can introduce nematodes, weed seeds, and other soil- and tuber-borne pests and pathogens to the field. Field spreading may not be the best option in very late winter, spring, or summer when temperatures are too warm to freeze potatoes. In general, potatoes must be exposed to temperatures at or less than 28°F for at least twenty-four hours in order to completely freeze.

Freezing causes cells to rupture within the tuber, accelerating breakdown and decay once it thaws. Weather conditions during the winter also allow the potatoes to substantially desiccate, which can make spring field tillage easier. Avoid tilling the field until cull potatoes have had sufficient time to freeze and desiccate. Premature tilling could bury live tubers deep enough into the soil to insulate them from further exposure to killing temperatures. The inadequately frozen potatoes could emerge as volunteer plants later in the spring and become a source of disease and insect problems.

It is extremely important to spread cull potatoes no more than two potato layers deep (approximately 6 inches) during field disposal. A thick layer often merely insulates the potatoes underneath from freezing. Shredding the potatoes with a silage or forage chopper prior to land application decreases the chances of potatoes producing new growth; indeed, smaller pieces make the tuber tissue more susceptible to decomposition.

Risk of volunteer potatoes. Even with these precautions, fields where spreading occurs must be monitored in the spring for volunteer potatoes (Figure 2). As with tubers left in a field during harvest, cull tubers that have been spread in a field could still sprout if, for instance, snow covered and insulated them from freezing. Manage the volunteers with appropriate herbicides or tillage depending upon the current crop and rotation. An important point regarding volunteer potato management is the timing of tillage and/or herbicide application. If done too early or inadequately, the cull tuber may resprout. As a result, additional measures may be needed. However, it is critical to kill the volunteer potato plants before they reach tuber initiation (Figure 3) to avoid the possibility of producing daughter tubers that could, in turn, produce volunteers in subsequent years.

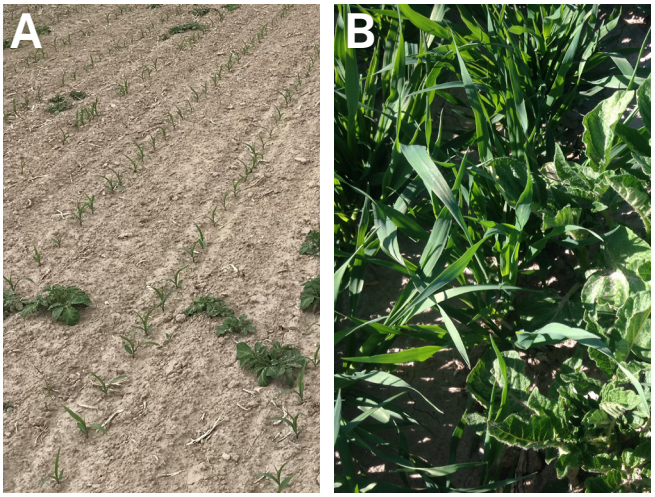

Figure 2. Volunteer potatoes in corn **(A)** and small grains **(B)**.

Figure 3. Tuber initiation (indicated by yellow arrow).

Fertilizer benefits of cull potatoes. Since cull potatoes are a significant fertilizer source, there is a benefit when calculating the fertility requirements of a crop planted in the field after winter spreading. Grain or forage crops are particularly good candidates for using cull potatoes as a partial fertilizer source.

Table 1 provides generalized information on the nutrients cull potatoes contain and could potentially contribute to a crop planted after winter field spreading. To ensure proper decomposition, and allow as much freezing as possible, spread cull potatoes no more than 6 inches deep. As a result, there are limits to how many pounds of nutrients will be available.

Table 1. Nutrient composition and content of cull potatoes.

Nutrient	Dry Weight (%)
Calcium	0.14
Phosphorus	0.27
Magnesium	0.11
Potassium	1.88
Sodium	0.04
Chloride	0.26
Sulfur	0.14
Cobalt	0.57
Copper	0.0006
Iron	0.0134
Manganese	0.0012
Selenium	0.01
Zinc	0.0015

Source: National Academies of Sciences, Engineering, and Medicine (NASEM), 2016.

2. Burial

Burying cull potatoes is a viable disposal method anytime during the year. This is an especially good option when the winter weather is no longer severe enough to freeze and kill them. For this disposal method, excavate large trenches in a location with a low water table and away from any water source. Trenches must be large enough to accommodate not only the cull potatoes but also at least 18 inches of soil to be placed over the top of the pile. More soil may be needed if sprouts begin to emerge. When covering potatoes with soil, avoid using tare dirt or other sources that may contain small pieces or slivers of potato tubers.

Ideally, alternate layers of potatoes and layers of soil when trench filling. Layering facilitates the breakdown of buried potatoes. Mound soil over the pile to divert surface water away from the site. Additional soil may also be needed on top as the buried potatoes begin to settle.

3. Livestock Feed

As mentioned previously, cull potatoes are rich in minerals (Table 1) and can be considered for use in livestock feed. This information is valuable since cull potatoes are considered for use in livestock feeds. They are an excellent source of energy (Table 2) for livestock and can be incorporated into properly balanced rations. Adding cull potatoes into a livestock ration can be both an economical disposal method and a good source of a feeding supplement. Potatoes are often used in livestock rations to replace a portion of the grain that is contained in the ration. Table 2 provides a comparison of the nutrient values of cull potatoes, barley grain and corn grain. Cull potatoes can substitute for barley grain fed at a ratio of 4.5 pounds (wet weight) of potatoes per 1 pound of grain. Cull potatoes may be used to replace up to 50% of the grain needed for beef cattle, while dairy cattle rations should not have more than 20%–25% of the normal concentrate replaced with potatoes.

Potatoes as a feed source differ from other sources in several important ways. Cull potatoes have much less fiber than most grains (e.g., 2.5% versus 5.6% for barley, respectively) and, when using potatoes in livestock rations, a roughage source is needed to maintain normal rumen function. Introduce potatoes

into an animal's diet gradually. Begin by adding 2–3 pounds of potatoes per day to the animal's diet and increase the amount in the ration by 2–3 pounds per day until you reach the desired level. The lower fiber level is especially important in dairy rations because low fiber levels reduce butterfat production in lactating cows.

Potatoes also have a relatively low dry-matter content (20%–25%; Table 2). If cull potatoes are used in livestock rations with other high-moisture feeds, total dry matter intake may decline and animal performance could suffer. Protein nutrition is another factor. Although potatoes are easily digestible, much of the protein found in them is in the form of nonprotein nitrogen, considered low in digestibility by calves. Fortunately, even though calves cannot utilize nonprotein nitrogen, mature animals digest and use this form more efficiently.

Using fresh cull potatoes for feed may provide the best results. The cull potatoes should be reasonably clean and free from dirt. Some producers prefer to wash the tubers before feeding, while others have had good success feeding those that have come directly from storage. Note that stockpiling or storing potatoes can result in reduced palatability and potentially dangerous toxin development if potatoes spoil or turn green. If the cull potatoes must be stored before use, ensiling them in the following manner may be the best option: chop and mix 100 pounds of potatoes with 20–25 pounds of straw, dry hay, or chaff as the feedstuffs are added to the silage pit/bag. Other methods of ensiling include mixing 500 pounds of chopped potatoes with 1 ton of corn silage.

There are risks associated with feeding cull potatoes to livestock. Choking and poisoning are two primary concerns, with choking posing the greater risk. Potatoes can be chopped or crushed to reduce the risk of choking, but proper feeding management also reduces the risk of choking to the degree that chopping or crushing may be unnecessary. Try to keep the cows' heads down and throats extended when feeding cull potatoes to lessen the likelihood of choking. If bunk feeding potatoes to cattle, use a rail, cable, or electric fence wire 2–3 feet above the bunk to keep the cattle's heads down. When feeding on the ground, feed in large quantities so there is no competition among the animals. The practice prevents the animals from gulping the potatoes. Softened or flaccid potatoes are also desirable. Do not feed them solid, frozen potatoes, because cattle are unable to chew them, thus increasing the likelihood of choking.

Poisoning of animals being fed cull potatoes comes primarily from toxic glycoalkaloids that develop in potatoes under certain conditions. Glycoalkaloids can develop and accumulate to toxic levels in potatoes that are green or sunburned due to light exposure and are also present in culls that have sprouted. Therefore, avoid using them in the feed ration. Symptoms of glycoalkaloid toxicity include staring eyes, dilated pupils, trembling, staggering, weakness, and, occasionally, convulsions. If these symptoms occur, remove the cull potatoes from the ration immediately.

Using cull potatoes for livestock feed is an option as long as both the disposal of manure produced by the livestock and the cattle's feeding are accomplished on non-potato ground. Pieces of potato not fully eaten or digested by the cow are still intact and, if dropped on the soil, potentially enhance nematode and disease survival. In addition, several potato pathogens (such as the one that causes powdery scab) can survive the digestive process even if potatoes are otherwise fully utilized by an animal.

Potatoes produced using pesticides and other crop-protection products are safe for consumption when product labels are adhered to and followed. Unless specifically stated, use culls from those potato fields as livestock feed. Review the postharvest interval (PHI) included on every label. The PHI is basically a "cut-off date" for applications. For instance, a potato herbicide with a 60-day PHI cannot be applied within 60 days of potato harvest. If the PHI has been met, the cull potatoes from that field should pose no risk to animals. To ensure animal health and safety and reduce the risk of residues in animals, always read and follow product-label directions. If a cull pile itself has been directly sprayed with herbicides or other pesticides, potatoes from the pile should not be used for human or animal consumption unless allowance is stated in the label.

Table 2. Nutrient values of cull potatoes, barley, and corn grain for livestock feed.

Nutrient (unit)	Potatoes	Barley	Corn
Dry matter (DM), % DM	23.54	89.69	83.28
Neutral detergent fiber, % DM	11.19	18.29	19.41
Acid detergent fiber, % DM	7.32	7.09	9.04
Lignin, % DM	1.10	1.75	1.80
Starch, % DM	6.87	56.74	60.68
Ether extract, % DM	7.52	2.20	3.60
Crude protein (CP), % DM	10.11	12.78	8.28
Ruminally degradable protein, % CP	37.60	49.14	36.27
Ruminally underagable protein, % CP	62.40	50.77	63.59
Soluble crude protein, % CP	64.71	27.58	24.68
Acid detergen insoluble CP, % DM	1.77	2.21	3.24
Total digestible nutrients, % DM	76.70	84.10	84.60
Metabolizable energy, Mcal/kg	2.77	3.04	3.06
Net energy maintenance, Mcal/kg	1.84	2.06	2.08
Net energy gain, Mcal/kg	1.21	1.40	1.41

Source: NASEM, 2016.

4. Compost

Cull potatoes can be composted, but the procedure must be done properly to ensure tubers are rendered nonviable. An improperly managed compost pile is merely a cull pile in disguise. Care and management are needed to make this a feasible disposal option. Proper composting requires adequate temperatures, air circulation, moisture, and suitable carbon-to-nitrogen (C:N) ratios. Research at Michigan State University demonstrated that a temperature of approximately 113°F was required to kill the late blight pathogen. Much higher compost pile temperatures are both possible and desirable. Typically, temperatures need to be 120°F–155°F to be most effective. Aeration is also very important because many microorganisms involved in the decomposition process require oxygen, a requirement met by frequent and consistent turning of the pile. In general, the more a pile is turned and aerated, the faster its decomposition rate. Shredding potatoes prior to composting further enhances decomposition.

In general, successful compost piles require 40%–60% moisture content by weight. Potatoes contain about 80% moisture, so additional water is usually not needed. However, due to relatively high levels of moisture in potatoes, conditions may become so wet that a pile becomes anaerobic and foul smelling and will not compost correctly.

Care should be taken before using compost made from cull potatoes that have been directly sprayed with herbicide(s). Some herbicides applied at this time do not degrade during composting even if high temperature and aerobic conditions are maintained. If the culls must be used for composting, keep records of the herbicide(s) used and understand that a herbicide such as aminopyralid (Milestone) could render gardens and flower beds unproductive for some time, while use on noncrops or pastures could be safe.

When cull potatoes are used for compost, incorporate materials such as straw, sawdust, manure, or other plant residue into the compost in order to attain the 20:1 C:N needed within the pile to ensure proper decomposition.

In summary, composting is a possible means for disposing of cull potatoes, but because the process involves careful management and monitoring, this option may not be the best for many growers, especially those with large amounts of culls.

5. Chemical Options

Cull piles are technically noncrop areas. Some herbicides labeled for noncrop uses may be somewhat effective at killing sprouts and subsequent foliage emerging from culls (Table 3). Multiple applications may be necessary, especially since resprouting can occur. There are currently no herbicides capable of "killing" a tuber, so there is a possibility of potato pathogen persistence in this "living reservoir," even though sprouting foliage is controlled.

Table 3. Examples of herbicides* labeled for control of broadleaves in noncrop areas.

Chemical Name	Example Trade Names*
2,4-D	Various trade names
Bromacil + diuron	Krovar
Clopyralid	Stinger, Transline
Dicamba	Banvel, Clarity, Vanquish
Fluroxypyr	Starane Ultra
Imazapic	Plateau
MCPA	Various trade names
Aminopyralid	Milestone
Bromoxynil	Buctril
Clopyralid + 2,4-D	Curtail
Diuron	Karmex
Flumioxazin	Payload
Glyphosate	RoundUp PowerMax and others
Imazapyr	Arsenal
Triclopyr	Garlon

**Listing of a trade name does not indicate endorsement.*

Several desiccation products, including those used for potato vine kill, can be used:

- Carfentrazone-ethyl (Aim and others)
- Diquat (Reglone and others)
- Glufosinate-ammonium (Rely and others)
- Pyraflufen ethyl (Vida)

Herbicide application to cull piles could be considered as spot spraying with the possible use of wands and single nozzle-type spraying. Read and follow the label. As always, when treating any area that includes cull piles with herbicides, avoid drift onto off-target areas, including cropped fields, due to the potentials for immediate or long-term crop damage. NOTE: As stated earlier, potatoes from a cull pile that has been directly sprayed with herbicides and other pesticides should not be used for human or animal consumption unless allowance is stated in the label.

Monitoring Cull Piles and Cull Pile Sites

Regardless of the strategy implemented for cull potato management, the first step is to choose the site of a cull pile carefully. Cull piles and areas where cull piles have been disposed need to be carefully monitored to ensure no detrimental environmental effects are occurring. Rotting potatoes are a potential source of odors and readily attract a variety of undesirable pests. The problem is greatly magnified when air temperatures begin to warm. The potential for environmental damage and for nuisance problems are very good reasons to select your disposal sites carefully.

Cull potato piles that have accumulated over the winter months may or may not sprout the following spring, but they still need to be monitored. The dynamics of cull piles have been studied and potatoes on the outside surfaces of a cull pile most likely freeze and die during the winter months. In contrast, potatoes in the center of a pile usually suffer from a lack of oxygen and succumb to bacterial soft rot, a process that also generates heat.

In between these extremes is a zone where potatoes may escape both freezing and rotting. Depending on outside air temperatures, potatoes at some

distance below the surface are insulated from both outside and internal influences and can survive even the coldest winter conditions. The zone where potatoes may survive depends on the duration of low air temperatures and the size and depth of the pile. Research at Michigan State University demonstrated that potatoes below the surface of a pile rarely get below 32°F. Generally, potatoes die after 24 hours at 28°F or 12 hours at 25°F. Naturally, the deeper and wider the cull pile, the larger the survival zone and the greater the likelihood that some of the cull potatoes will still be able to sprout in the spring.

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