

## The Oklahoma Cooperative Extension Service WE ARE OKLAHOMA

The Cooperative Extension Service is the largest, most successful informal educational organization in the world. It is a nationwide system funded and guided by a partnership of federal, state, and local governments that delivers information to help people help themselves through the land-grant university system.

Extension carries out programs in the broad categories of agriculture, natural resources and environment; family and consumer sciences; 4-H and other youth; and community resource development. Extension staff members live and work among the people they serve to help stimulate and educate Americans to plan ahead and cope with their problems.

Some characteristics of the Cooperative Extension system are:

- The federal, state, and local governments cooperatively share in its financial support and program direction.
- It is administered by the land-grant university as designated by the state legislature through an Extension director.
- Extension programs are nonpolitical, objective, and research-based information.
- It provides practical, problem-oriented education

for people of all ages. It is designated to take the knowledge of the university to those persons who do not or cannot participate in the formal classroom instruction of the university.

- It utilizes research from university, government, and other sources to help people make their own decisions.
- More than a million volunteers help multiply the impact of the Extension professional staff.
- It dispenses no funds to the public.
- It is not a regulatory agency, but it does inform people of regulations and of their options in meeting them.
- Local programs are developed and carried out in full recognition of national problems and goals.
- The Extension staff educates people through personal contacts, meetings, demonstrations, and the mass media.
- Extension has the built-in flexibility to adjust its programs and subject matter to meet new needs. Activities shift from year to year as citizen groups and Extension workers close to the problems advise changes.



## Sweet Potato Production

### EXTENSION

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Oklahoma Cooperative Extension Fact Sheets are also available on our website at: [extension.okstate.edu](http://extension.okstate.edu)

### Production Requirements

Sweet potato is a nutritious root crop that contains significant amounts of fiber, beta carotene and vitamin C, particularly in varieties with highly colored roots. It is native to tropical areas including Central and South America. This crop thrives during summer's warm days and nights, which are required for optimal growth and root development. When sweet potato is managed properly, it has the potential to be one of the more profitable vegetable crops grown in Oklahoma. It can be stored



for several months when cured properly and held under proper conditions, making it possible to market sweet potato through an extended period of time. That said, it is not a "get rich quick" crop since it requires significant commitments of capital, time, and management to make it profitable. Even with the use of mechanical harvesters and other production technology, labor requirements are about 60 man-hours per acre. Sweet potato production is not recommended for growers who do not plan to grow the crop for several years. Profitable production practices include using good seed stock or purchasing certified slips; selecting suitable soil; following good production practices, including fertility, irrigation, pest management and careful harvesting; handling, curing and storing of sweet potato roots.

### Expected Yield

Yields of sweet potato in Oklahoma can vary considerably due to site, soil, weather, and crop variety. Under ideal conditions, very high yields can be attained, but more likely yields will range between 300 to 350 bushels (bushel=50 lbs.) per acre of U.S. No. 1's. Another aspect of marketable yield to be considered are other classes of marketable roots including canners and jumbos, which will provide additional income for producers, if markets are available or can be developed.

Table 1. Sweet potato varieties.

Variety-release date	Flesh color	Notes
Beauregard-1987	Orange	Resistant to Fusarium wilt & root rot, Rhizopus soft rot
Bonita- 2011	White	Resistant to root knot nematode, Fusarium wilt
Centennial-1962	Orange	Resistance to wireworm, Fusarium internal cork
Cordner-1983	Orange	Resistant to root knot nematode, early yielder, good slip producer
Covington- 2005	Orange	Resistant to root knot nematode
Evangeline- 2008	Orange	Resistant to root knot nematode, Fusarium wilt & root rot, Rhizopus soft rot
Jewel-1970	Orange	Resistance to root knot nematode & Fusarium wilt
O'Henry-	Cream	Resistance similar to Beauregard
Southern Delight-1986	Orange	Some insect resistance, good slip producer

Websites for further information on sweet potato varieties:

- [https://suagcenter.com/portals/our\\_offices/research\\_stations/sweetpotato/features/varieties/sweet-potato-variety-descriptions](https://suagcenter.com/portals/our_offices/research_stations/sweetpotato/features/varieties/sweet-potato-variety-descriptions)
- <https://potatoes.cals.ncsu.edu/sweetpotato/sweetpotato-varieties/>
- <https://kerrcenter.com/publication/heirloom-variety-trial-report-2010-sweet-potato/>

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## Sites and Soils

Sweet potatoes produce best in a well-drained, light, sandy loam or silt loam soil. Rich, heavy soils produce high yields of low-quality roots, and extremely poor, light sandy soils generally produce low yields of high-quality roots. Both surface and internal drainage are important in selecting a field. Poor surface drainage may cause wet spots that reduce yields. Poor internal drainage will also reduce yields. Soils with poor internal drainage are characterized by a high moisture content and poor aeration, which cause sweet potato roots to be large, misshapen, cracked, and rough skinned. A three- to five-year rotation program should be used to reduce the chance of soil-borne disease problems.

## Varieties

Sweet potato variety selection should be based on several characteristics including market preference, pest resistance, yield, quality and potential for slip production. As with all vegetable crops, market demands are a large factor in variety selection, so is the potential for a variety to be productive. It is also important to try new varieties in on-farm trials, and if they are successful, introduce them to customers so they can provide input for future variety decisions. Sweet potato varieties to consider are given in Extension Fact Sheet HLA 6035 "Commercial Vegetable Varieties for Oklahoma" available on-line at: <https://extension.okstate.edu/fact-sheets/commercial-vegetable-varieties-for-oklahoma.html>. Another good source of information on variety selection is Oklahoma State University's Vegetable Trial Reports MP-164; sweet potato trials were completed in 2012, 2013, 2014. Trial results are available on-line at: <https://agriculture.okstate.edu/departments-programs/hla/research-extension/vegetables/trial-report.html>.

## Soil pH and Fertilizer

Sweet potatoes are tolerant of variations in soil pH between 5.5 and 6.8. However, the optimum soil pH for high yields of quality sweet potatoes is 5.8 to 6.0. Apply lime if soil pH is too low. A crop of sweet potatoes utilizes about 110 pounds of nitrogen, 15 pounds of phosphorus, and 150 pounds of potassium per acre from the soil. Based on OSU soil test results, the following amounts of P<sub>2</sub>O<sub>5</sub> (phosphorus) and K<sub>2</sub>O (potassium) are recommended (Table 2). Fertility recommendations based on soil test results for specific vegetable crops can also be found on-line by going to [www.soiltesting.okstate.edu](http://www.soiltesting.okstate.edu). Other fertility recommendations are available in Fact Sheet HLA-6036 "Soil Test Interpretations for Vegetable Crops."

**Table 2. Phosphorous and potassium requirements for sweet potato.**

Phosphorous Requirements (lbs P <sub>2</sub> O <sub>5</sub> /Acre)					
When test shows 0	10	20	40	>65	
Add lbs. P <sub>2</sub> O <sub>5</sub>	120	100	80	45	0
Potassium Requirements (lbs K <sub>2</sub> O/Acre)					
When test shows 0	75	125	200	>250	
Add lbs. K <sub>2</sub> O	120	100	80	40	0

**Nitrogen-** Pre-plant apply 30 pounds per acre of nitrogen along with P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O by using a complete fertilizer. With most soils, but certainly sandy soils, leaching of nitrogen will occur. It is best to use a split application of nitrogen to prevent leaching of nitrogen out of the root zone of the crop. In this case, 30 pounds would be applied pre-plant and incorporated into the soil with the second application of 30 pounds coming four to five weeks after transplanting into the field.

During transplanting, a starter solution high in phosphorus can be applied at a rate of one-half pint of solution per plant. This starter solution can be prepared by adding three pounds of soluble 15-30-15 in 50 gallons of water.

## Seed Root Selection

The process of properly selecting, curing and storing sweet potato roots for the production of slips (vine cuttings) is a key step in profitable sweet potato production. Remember, poor-quality seed roots will not produce the quality slips need for the establishment and production of high-yielding-sweet potato crops.

### Steps for maintaining high-quality seed stocks:

- Maintain a good supply of foundation stock. These are roots from which seed stock will be grown next year.
- "Hill-select" foundation stock by selecting hills that produce at least four U.S. No. 1 sweet potatoes.
- Choose well-shaped roots that are free from insects and diseases as well as true to variety.
- Check the flesh color by cutting off about 1/2 inch of root nearest the stem end. Discard 'off' types (mutants) if they are found.
- Four bushels to six bushels of foundation stock will grow vine cuttings to plant one acre of sweet potatoes for seed stock production.
- Produce seed stock from vine cuttings taken from foundation stock and planted on disease-free soil.
- Handle seed stock potatoes very carefully - with cotton gloves. Harvest before frost and cure and store separately from other sweet potatoes.
- Never let seed stock remain in the field unprotected from the sun after digging.



**Figure 2. Seed stock for sweet potato production.**

## Containers

Containers are important in handling, proper curing and storage of sweet potatoes. To minimize handling and reduce injury, containers used to harvest potatoes in the field are used in curing and storage. Bushel crates or plastic boxes are usually used; however, consider using larger containers like plastic bin boxes since there is less potential for root damage with these containers. One advantage of plastic containers is effective cleaning and sanitizing before harvest, whereas wooden crates or baskets cannot be sanitized, resulting in higher potential for contamination by food-borne pathogens.

When deciding what containers to use, consider adoption of a standard size and type to simplify transport and storage.

## Curing

Sweet potatoes to be stored for later marketing or for seed stock must be cured immediately after harvest to minimize storage losses. Do not wash potatoes to be cured and stored. Curing involves controlling temperatures and relative humidity and providing ventilation for seven to ten days. Curing is a wound-healing process which occurs most rapidly at 80 F to 90 F, a relative humidity of 85 percent to 90 percent, and good ventilation to remove carbon dioxide from the curing area. Wounds and bruises will heal and a protective cork layer will develop over the entire root surface. In addition, suberin, a waxy material, is deposited. The cork layer and suberin act as a barrier to decay-causing organisms and to moisture loss during storage.

## Storage

Store sweet potatoes between 55 F and 60 F. Do not allow temperatures to fall below 55 F or chilling injury will result. Relative humidity should be maintained between 75 percent to 80 percent to prevent excessive water loss from the roots. Some ventilation should be provided to prevent carbon dioxide buildup.

## Grading and Marketing

Whether marketed from the field or from storage, fresh market sweet potatoes are usually washed, graded and often waxed before marketing. Poorly shaped, diseased, and damaged roots should be graded out to make a good-looking pack. Buyer requirements for grade and size must be met for repeat sales. Fresh market sweet potatoes are usually packed in 40- or 50-pound cartons.

Small acreages of sweet potatoes can be marketed by pick-your-own methods. Only dig potatoes that will be picked up by customers during the next hour to prevent sun scald injury. Farm to School programs, roadside stands, farmer's markets, and local stores are other possible markets for small producers. Some processing potatoes are produced in Oklahoma. Be sure to determine processor requirements prior to production and delivery. There may be size restrictions on processing deliveries or potatoes may be delivered field run with culls removed.

## References

- 1 Pre-sprouting sweet potatoes, Peirce, L.C. Vegetables, Characteristics, Production, and Marketing. 1987, John Wiley and Sons, New York.



**Figure 10. Black rot, Fusarium stem rot and scurf in sweet potatoes.**

## Soil Moisture

Inadequate soil moisture is a consistent limiting factor in Oklahoma sweet potato production. Rains are rarely spaced to provide uniform and adequate moisture throughout the growing season. Supplemental irrigation should be available to supply up to 1½ inches of water every seven to ten days. Actual needs will vary with soil type, plant size and weather conditions. Too much water is harmful and will reduce yield and quality. Moisture should be withheld toward the end of the growing season to condition the soil and roots for harvesting, and to discourage the development of cracks in roots and jumbo size roots. Irrigation systems have been discussed somewhat in the transplanting section, but the primary systems used in Oklahoma would include overhead and drip irrigation. Over-head systems could include pivot or linear systems, pipe and risers or a side-roll system. Drip irrigation is operated on a more frequent basis with irrigations scheduled often daily or multiple times per day. This is the major difference between overhead and drip systems, i.e., with overhead systems based on applying substantial amounts of water on a less frequent basis and drip systems applying small amounts of water on a very frequent basis. Each system has advantages and disadvantages. Growers not equipped with irrigation systems should consult an irrigation engineer to determine which type of system would work best for their operation.

## Harvesting

Regular field inspection is needed to determine when to harvest. Sweet potatoes can be harvested any time after sufficient numbers of roots have reached marketable size. The price for uncured potatoes in late August and September may be high enough to justify sacrificing some yield to begin digging and marketing early. If the crop is to be stored, harvest just before frost to maximize yields. When soil temperature falls below 55 F, some damage to root quality and reduction in their worth for storage and slip production will result. Chilling injury can occur even though a frost has not occurred. In cool weather, remove all dug potatoes from the field before nightfall. Prevent sunscald by removing or protecting harvested potatoes from the sun. A 30-minute exposure to the sun can cause sunscald, reducing quality.

Most mechanical harvesters require vines to be cut with a rotary mower or otherwise removed to prevent interference with digging. Smaller acreages can be dug with a turning

plow or a middle buster. For a larger planting, a three-point hitch chain-type digger is best. Complex harvesters are now available for large acreages. These require little labor and deliver potatoes directly into containers. Regardless of the equipment used, it should be adjusted and operated to minimize skinning and bruising. Field grading is important. Use cotton gloves to prevent skinning. Place No. 1's and No. 2's in crates together and cuts, cracks, jumbos, and culls in separate containers. Only store roots that are marketable or those being held as seed roots for next season's crop. Size characteristics of the various grades are as follows:

- U.S. Extra No. 1. (a) Size - (1) Length shall be not less than three inches or more than nine inches. (2) Maximum weight shall be not more than 18 ounces. (3) Maximum diameter shall be not more than 3 ¼ inches. (4) Minimum diameter, unless otherwise specified, shall be not less than 1 ¾ inches.
- U.S. No. 1 and U.S. Commercial. (a) Size - (1) Maximum diameter shall be not more than 3 ½ inches. (2) Maximum weight shall not be more than 20 ounces. (3) Length, unless otherwise specified, shall be not less than three inches or more than nine inches. (4) Minimum diameter, unless otherwise specified, shall be not less than 1 ¾ inches.
- U.S. No. 1 Petite. (a) Size. (1) Diameter shall be not less than 1 ½ inches or more than 2 ¼ inches. (2) Length shall be not less than three inches or more than seven inches.
- U.S. No. 2. (a) Size. Unless otherwise specified the minimum diameter shall be not less than 1 ½ inches and the maximum weight not more than 36 ounces.
- Length defined as: the dimension of the sweet potato, measured in a straight line between points at or near each end of the sweet potato where it is at least three-eighths inch in diameter.
- Diameter defined as: the greatest dimension of the sweet potato, measured at right angles to the longitudinal axis.

## Pre-Sprouting Seed Roots

Pre-sprouting seed roots prepares them for slip production and is similar to the root curing process done in the fall following harvest. It will shorten the amount of time required for slip production by approximately a week and increase the number of slips by two or three times, compared to roots that are not pre-sprouted. This process should begin with sorting and culling out roots that will not be used for slip production. Eliminate roots that are cracked, show signs of rot or those not of the correct size or shape. Use seed roots that are between one inch and three inches in diameter. Pre-sprouting requires temperatures to be maintained between 75 F and 85 F and relative humidity of 85 percent to 90 percent with good air movement provided by a small fan. Pre-sprouting should be started two weeks to four weeks prior to seed roots being bedded up for slip production. Roots are pre-sprouted and ready for bedding when most roots have sprouts 1/4 inch in length. Following pre-sprouting, conventional producers can apply a fungicide to reduce potential disease problems; see current edition of E-832 "Extension Agents' Handbook of Insect, Plant Disease, and Weed Control" for recommendations. However, slips can be grown without fungicides for organic production or if labeled fungicides are not available.

## Producing Slips "Plants"

Varieties differ in their ability to produce slips, but generally a bushel of sweet potatoes will produce 2,000 to 2,500 slips in two or three slip harvests. Four bushels to six bushels of roots will be needed to grow slips for each acre transplanted in the field. Slips can be grown in cold frames or heated beds. It is difficult to produce slips in open field beds in Oklahoma due to the potential for very cool spring temperatures during the slip growing season. Allow five weeks to six weeks for slip production in heated beds and seven weeks to eight weeks in cold frames. If roots have been pre-sprouted, they will sprout more quickly and can be bedded up a week later than roots not pre-sprouted. Pre-sprouting can be done by warming "seed" potato roots to 75-84 F at a relative humidity of 85-90% in a well-ventilated room for two to four weeks.

Place pre-sprouted roots in the plant bed with the sprouts upright; a few sprouts will be broken during handling, but this causes no noticeable reduction in slip production. Roots not pre-sprouted can be planted either as fungicide-treated or non-treated roots in the plant bed.

Permanent plant production beds are a potential source of disease. If permanent beds are used, remove, and discard the old soil to a depth of 12 inches. Disinfect the bed frames and covering material with a recommended disinfectant. To refill the beds, bring in clean topsoil from an area where sweet potatoes and nematode susceptible crops have not been grown. New soil can be sterilized using soil heating techniques prior to bedding roots.

Before bedding sweet potato roots for plant production, examine roots carefully and discard diseased, mutated, and bruised roots. Separate the roots to be bedded according to size. This attains an even planting depth and uniform sprouting. For conventional growers, seed potatoes can be treated with a recommended fungicide by dipping immediately before bedding. Dipping will help control surface infestations of black

rot, scurf, and root rot organisms. Washing seed potatoes that are not pre-sprouted before fungicide treatment will remove dirt, which reduces the effectiveness of the fungicide. Seed roots should not be washed unless they will be treated in a fungicide dip before bedding.

About 12 square feet of bed is needed per bushel of seed potato roots. Fertilize beds with two pounds per 100 square feet of bed using a complete fertilizer such as 10-10-10 or 12-12-12. The fertilizer should be mixed with the bed soil prior to bedding the roots. Allow slip beds to warm to 80 F prior to bedding, then lower the temperature to 70 F or 75 F once sprouting begins. Place roots in the bed so they are not in contact with each other, then cover them with two-inch mesh chicken wire, followed by two inches of clean sand or sandy soil. The mesh wire prevents roots from being pulled up when slips are pulled from the beds.

After bedding roots, sprinkle water over the bed to slightly moisten the soil, but do not overwater and create a soggy wet soil. Clear plastic can be placed directly over the plant bed surface. Remove the cover material when the slips push the covering up about two inches. Water the beds as needed to keep the soil moist. Keep the beds covered with a light-transmitting cover such as clear plastic, polycarbonate, etc. until the plants begin to emerge. Ventilate during the day to control air temperature in the beds. Air temperature in the beds should be kept under 90 F to produce good-quality plants. Pull plants when they are about eight inches tall. They should have at least five leaves, stocky stems, and a healthy root system. This type of plant is best for mechanical transplanting.

If transplants are to be grown for sale, contact the Environmental Resources and Horticulture section of the State Department of Agriculture (ODAFF), well in advance of production. They will provide regulations and requirements for growing and selling certified sweet potato slips.

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## Preparing Soil and Transplanting

The production of sweet potatoes depends on good soil aeration. Good aeration is achieved by proper field selection and by bedding the field prior to transplanting. Incorporating pre-plant fertilizer and "bedding-up" two weeks prior to planting allows the bed to settle before planting. The bed should be installed to provide an 8- to 10-inch rise in height after settling and transplanting.

Early planting is an important factor responsible for high yields. Field transplanting should be accomplished as soon as possible after slip pulling. If slips must be held for several days before transplanting, they are best held by "planting" the bottom end of stems into moist, soilless growing media in plastic containers. One container can hold a significant number of slips, which will begin to root out after a few days and can be held indefinitely. Cull weak and spindly slips for increased yield. Set slips deep with at least three nodes (joints where leaves attach) below ground level.



**Figure 3. Sweet potato flea beetle.** Photo courtesy WonGun Kim, Bugguide.net.



**Figure 5. Yellowstriped armyworm (*Spodoptera ornithogalli*).** Photo courtesy Russ Ottens, University of Georgia, Bugwood.org



**Figure 7. Beet armyworm (*Spodoptera exigua*).** Photo courtesy John Capinera, University of Florida, Bugwood.org



**Figure 4. Click beetle.** Photo courtesy Frank Peairs, Colorado State University, Bugwood.org



**Figure 6. Mottled tortoise beetle (*Deloyala guttata*).** Photo courtesy Whitney Cranshaw, Colorado State University, Bugwood.org



**Figure 8. Saltmarsh caterpillar (*Estigmene acrea*).** Photo courtesy Frank Peairs, Colorado State University, Bugwood.org



**Figure 9. Scarabs or scarab beetles.** Photo courtesy Alton N. Sparks, Jr., University of Georgia, Bugwood.org

#### Optimum planting dates in Oklahoma are:

- Southern and Central areas - from May 1 to June 15
- Northern areas - from May 10 to June 20

One- or two-row transplanters are commonly used, but smaller operations can transplant by hand if not larger than one acre. Investment in a transplanter as well as a digger should be considered if planning on growing sweet potatoes on an annual basis.

Irrigation immediately following transplanting is vital, as stand losses due to drying out can be a significant factor in reducing yields. Slips will be damaged if they are planted and left in the field for short intervals of time (more than one hour) without receiving irrigation. In Oklahoma, weather can be hot and dry during transplanting season with temperatures near or above 100 F. When heat is combined with wind, it creates a serious risk to freshly transplanted slips not watered immediately. There are several ways to approach this situation. First, if overhead or furrow irrigation is used, water should be applied immediately following transplanting, possibly either watering single rows or small blocks individually to reduce the time from transplanting to irrigation. Second, a transplanter can be altered to apply water onto each transplant as it goes into the ground, which will keep the transplant alive until the irrigation system is able to apply water. Lastly, if drip irrigation will be used in the field, it should be installed prior to trans-planting and be applying water during the transplanting operation, particularly in hand transplanted situations. These suggestions will result in very little loss of transplants and an adequate plant stand.

#### Plant Spacing

A common spacing is 12 inches between plants on rows that are spaced 36 inches to 42 inches between rows (12,500 to 14,500 slips per acre). Plant spacing depends on soil fertility and availability of irrigation water. In fertile soils, wide spacing results in excessive jumbo roots and rougher potatoes. Close spacing in very sandy soils may result in undersized roots. The spacing range given will provide a good starting point for growers, however adjustments may be considered as needed.

#### Weed Control

Weed control in sweet potato fields is critical for the first four to six weeks following transplanting. After this establishment period, most sweet potato crops will cover the ground completely and effectively shade out weeds. The critical issue is how to control weeds prior to the crop covering the ground completely. In conventional production, several herbicides can be used to provide weed control during this early period of crop establishment; consult the current edition of E-832 "Extension Agents' Handbook of Insect, Plant Disease, and Weed Control" for recommendations. In organic production, cultivation by tractor-drawn cultivators and by hand hoeing would be one way to approach weed control. Feeder roots soon occupy the entire bed. To prevent damage to roots, cultivate weeds with equipment that does not scrape or remove soil from the bed. Disc hillers, rolling cultivators or other implements that throw soil to the bed avoid root damage and increase the height of the bed. A final bed height of ten inches is desired by the last cultivation, when rapidly growing vines interfere thereafter. Less damage to vines will occur if rows are cultivated in the same direction each time. Weeds not controlled by chemicals and cultivation will require hand hoeing. In addition, mulching (plastic films or organic mulches) could be used to reduce weed competition in the field.

If the ground has been in sod the preceding season, soil insects such as wireworms and grubs can be a problem. Insecticides are generally applied either pre-plant or at planting for soil insect control. Otherwise, leaf-feeding insects such as the tortoise beetle and saltmarsh caterpillar are predominant pests of sweet potato. Flea beetles and yellow-striped cucumber beetle, and beet armyworms may be occasional pests. For specific insect control measures, see the latest edition of E-832 "Extension Agents' Handbook of Insect, Plant Disease, and Weed Control."

#### Diseases

The most common sweet potato diseases are scurf, stem rot (wilt), nematodes, black-rot and soft rots. These and other diseases can cause heavy losses in the field and in storage. They can be prevented or controlled by following recommended practices in selecting resistant varieties, selecting seed stock, producing transplants, selecting fields, and growing practices. Scurf, black-rot and stem rot usually come from disease-infested seed stock and can be controlled by a fungicide dip before bedding seed roots. Nematodes can come from infested growing beds or soil. Fields known to be infested with nematodes or other sweet potato diseases should be avoided. A three- to five-year rotation should be practiced. Soft rots and other storage disease problems can be reduced by sanitation and disinfection of the storage house, proper curing, and careful handling of the sweet potatoes during harvesting, curing and storage. For specific disease control measures, see the latest edition of the Extension Agents' Handbook.